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**Wendlandt et al.**

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(54) **RADIATION IMAGING CASSETTE**

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(51) **Int. Cl.**  
**B65H 5/00** (2006.01)

(52) **U.S. Cl.** ..... **250/589**

(58) **Field of Classification Search** ..... 250/581, 250/589, 484.3, 484.4; 378/169, 172, 182  
See application file for complete search history.

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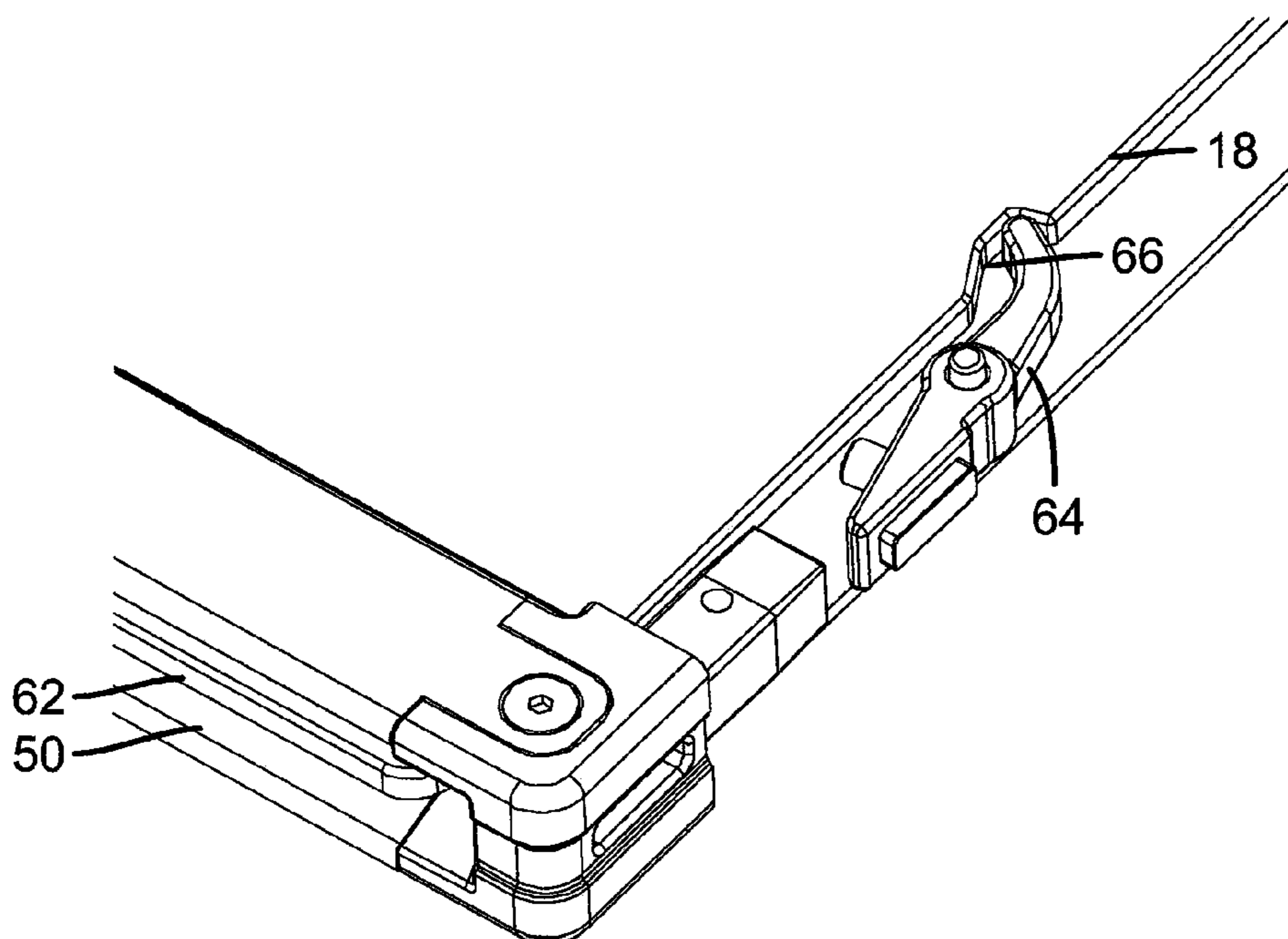
*Primary Examiner*—David P Porta

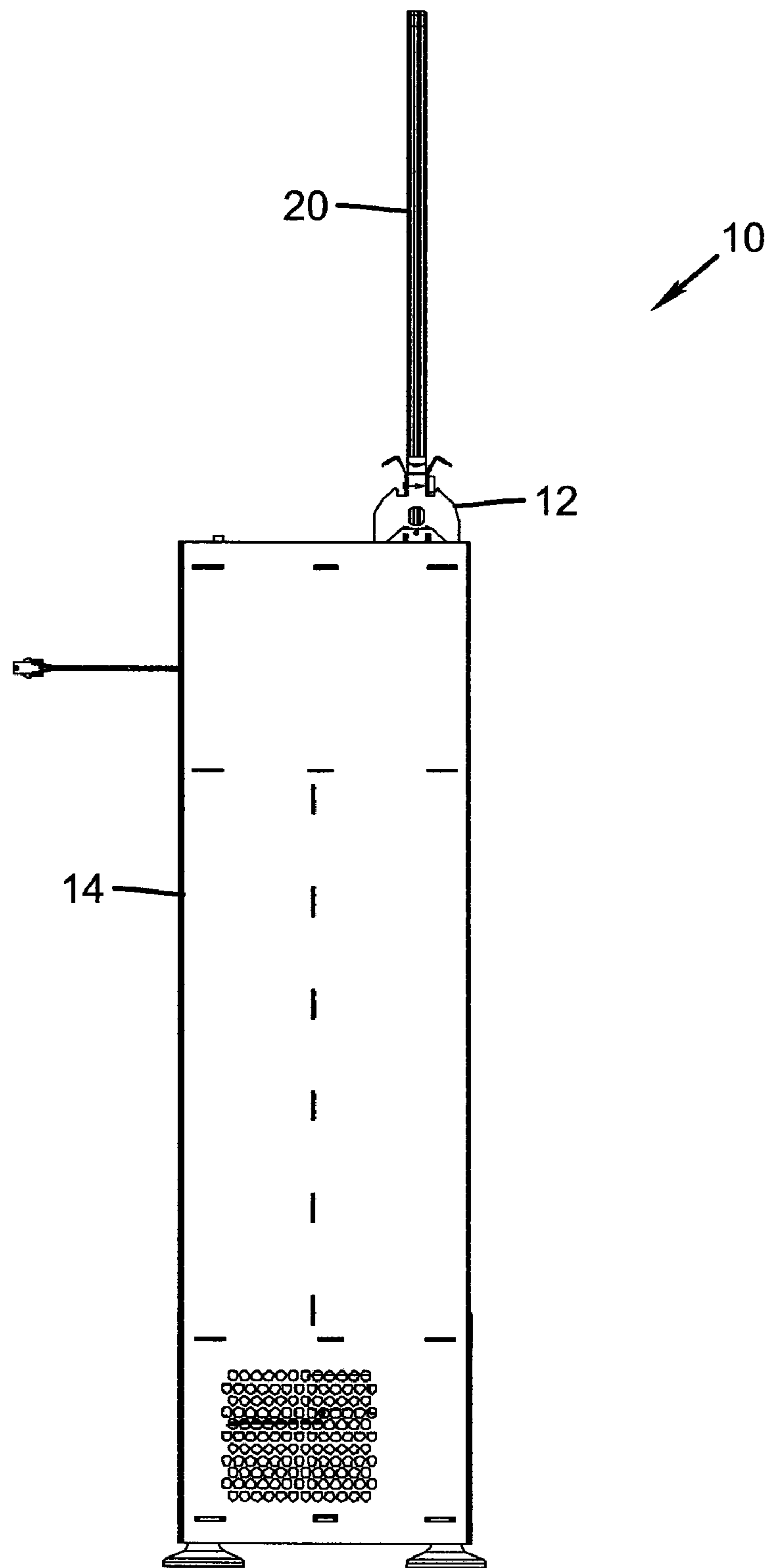
*Assistant Examiner*—Kiho Kim

(57) **ABSTRACT**

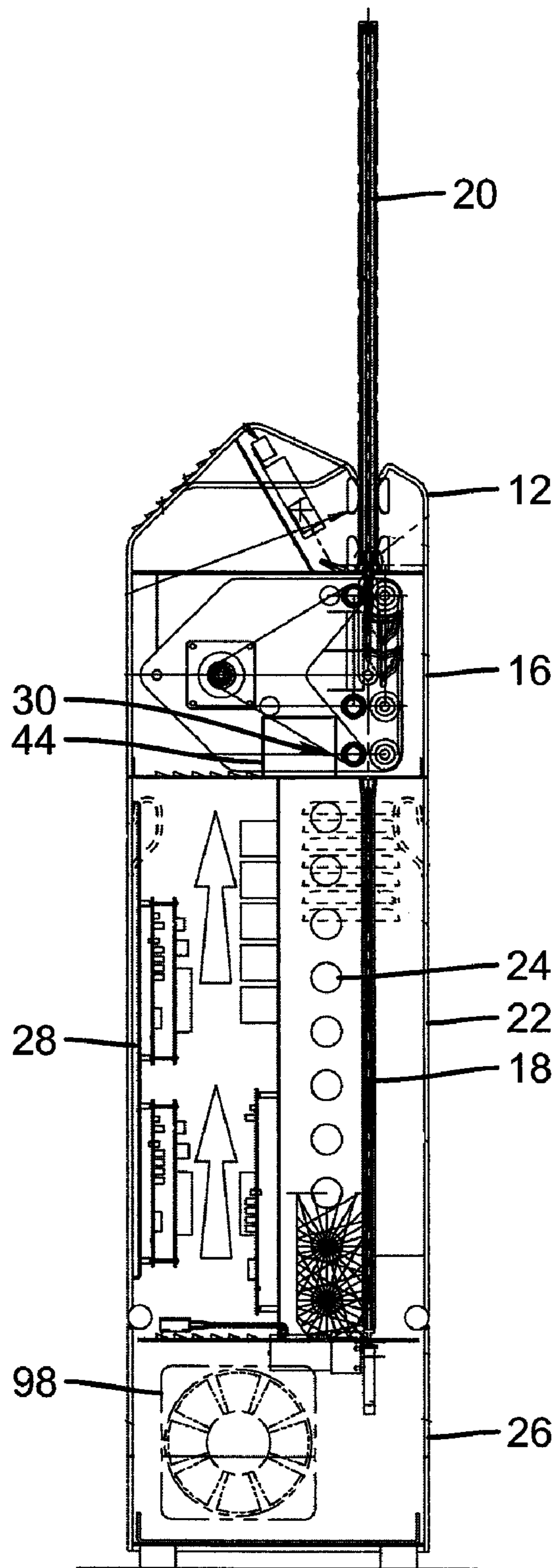
A radiation imaging cassette. The cassette includes a housing, a latch member, and guide edges. The housing is adapted to house a stimulable phosphor sheet. The housing includes a light-protected region and an opening for extraction and/or insertion of the stimulable phosphor sheet. The latch member releasably engages the stimulable phosphor sheet to secure at least a portion of the stimulable phosphor sheet within the light-protected region. The edge guides are disposed within the housing and operate to guide movement of the stimulable phosphor sheet through the opening.

**13 Claims, 29 Drawing Sheets**

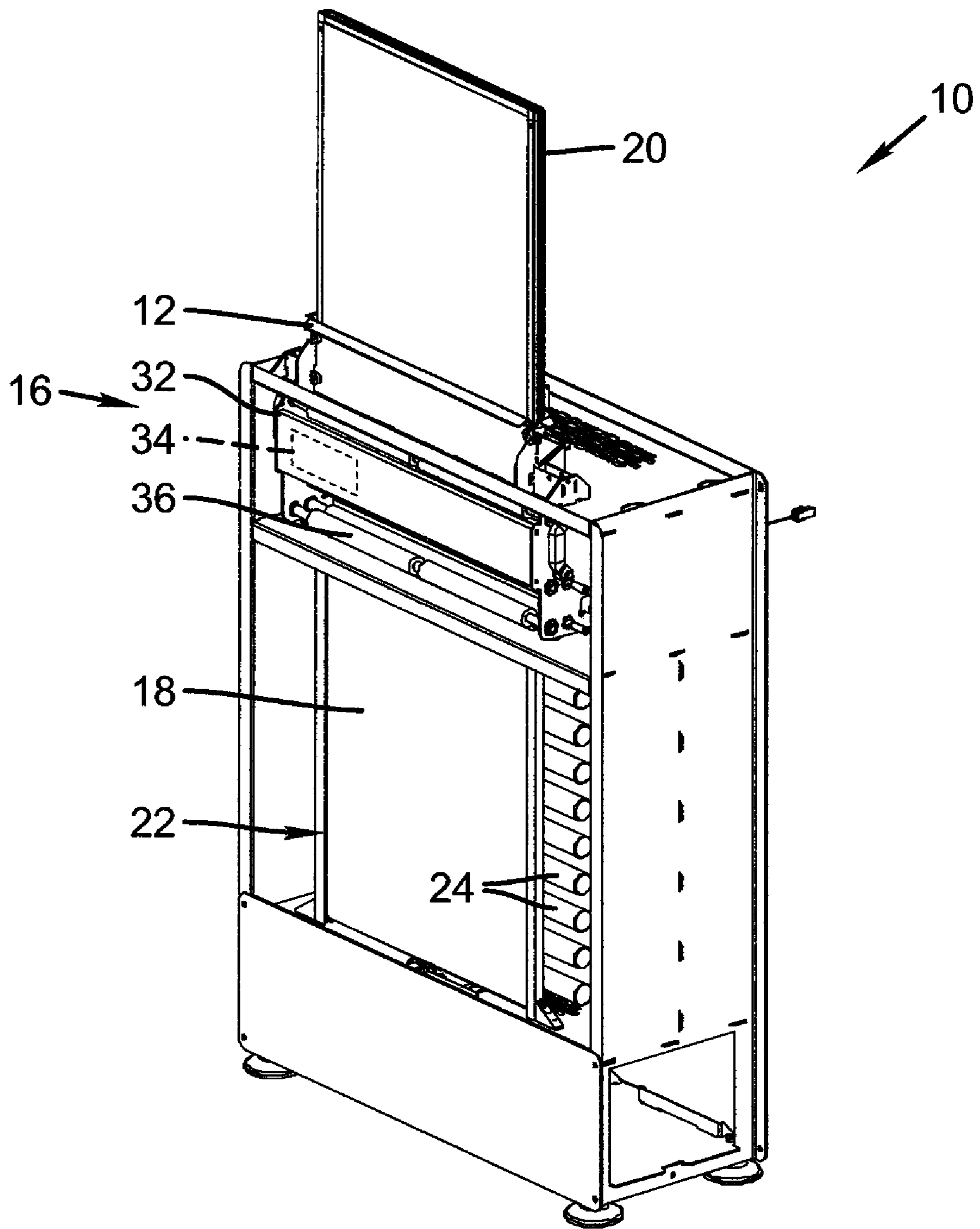




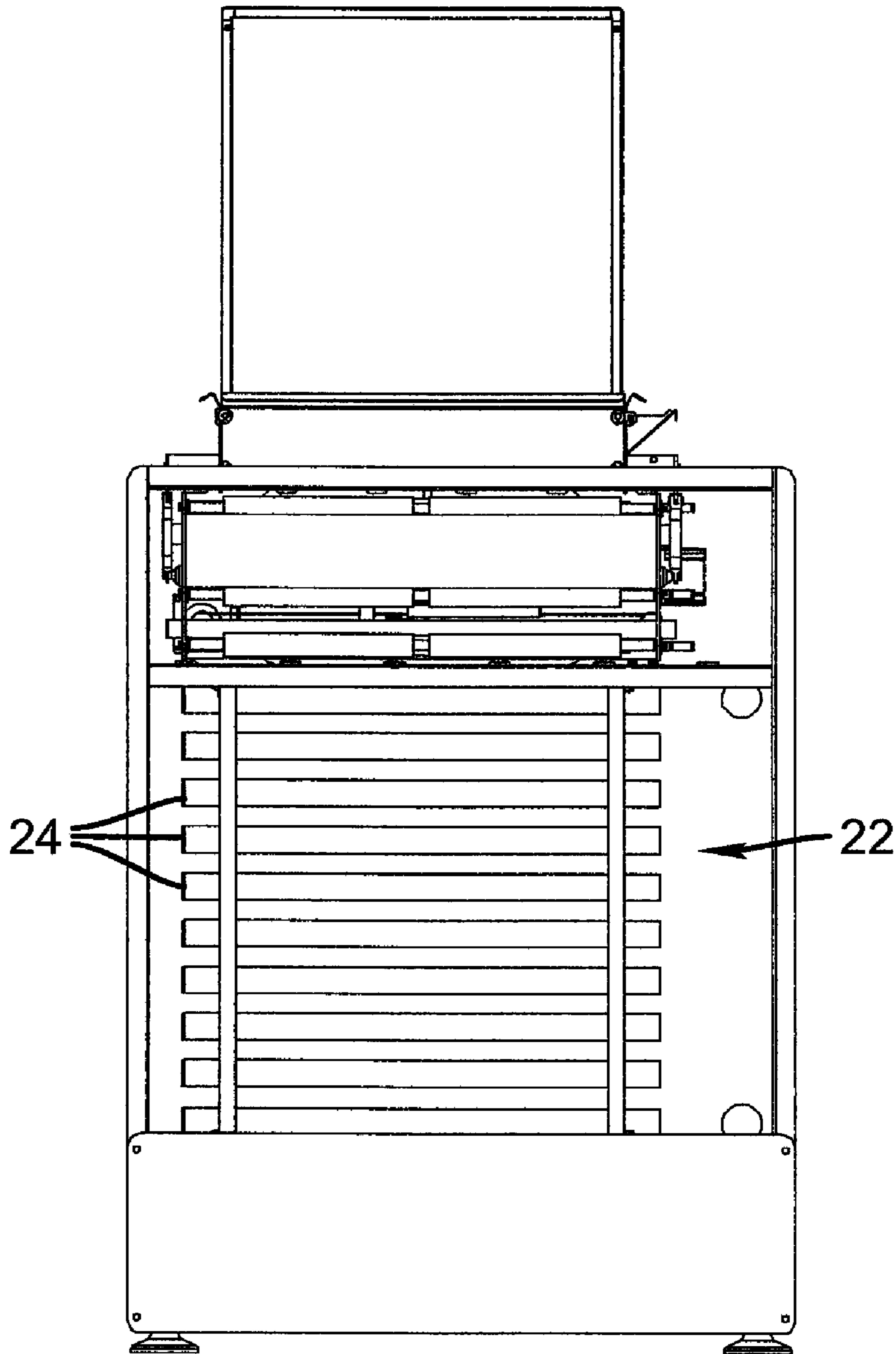
**FIG. 1**



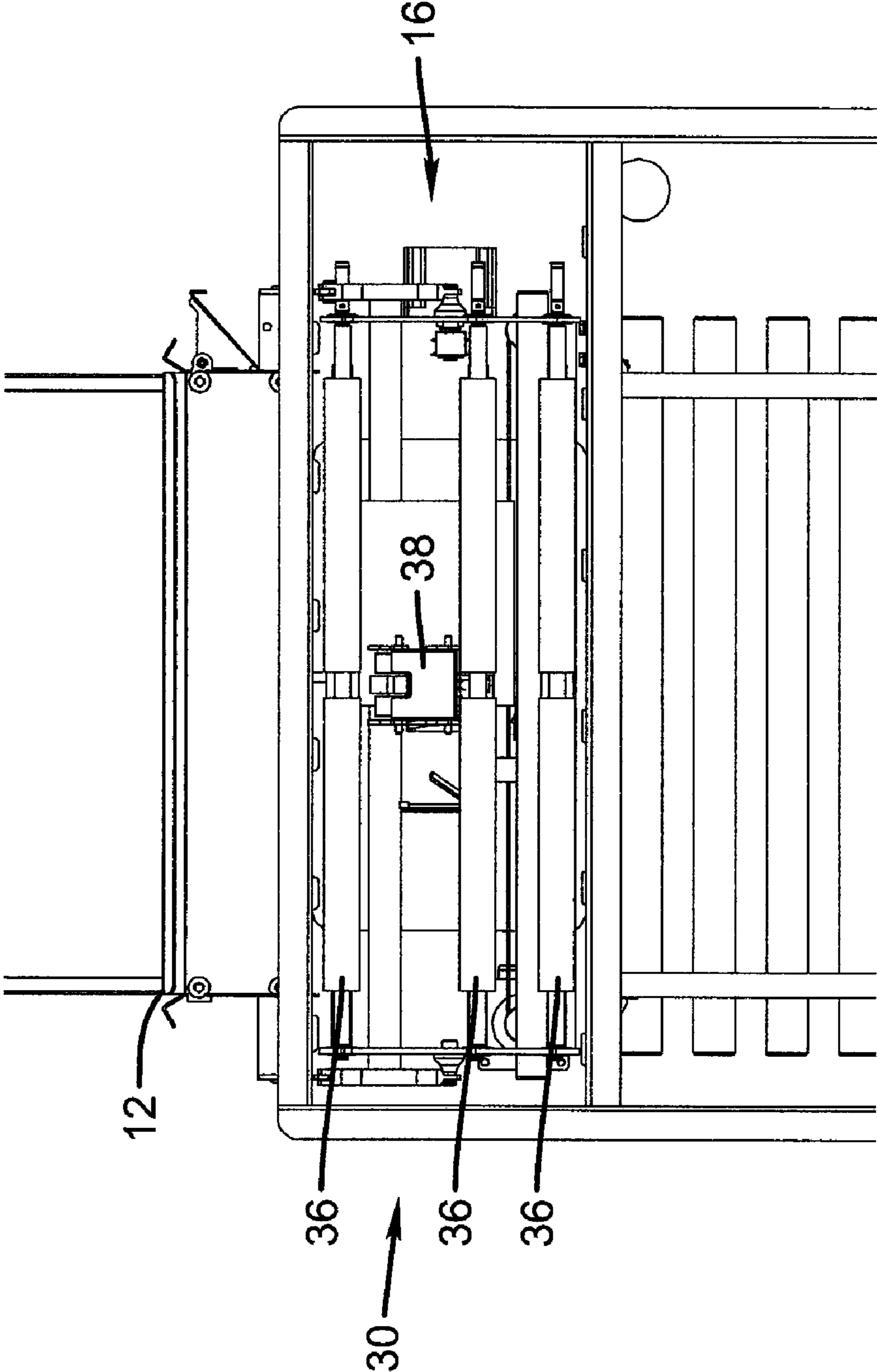
**FIG. 2**



**FIG. 3**



**FIG. 4**



**FIG. 5**

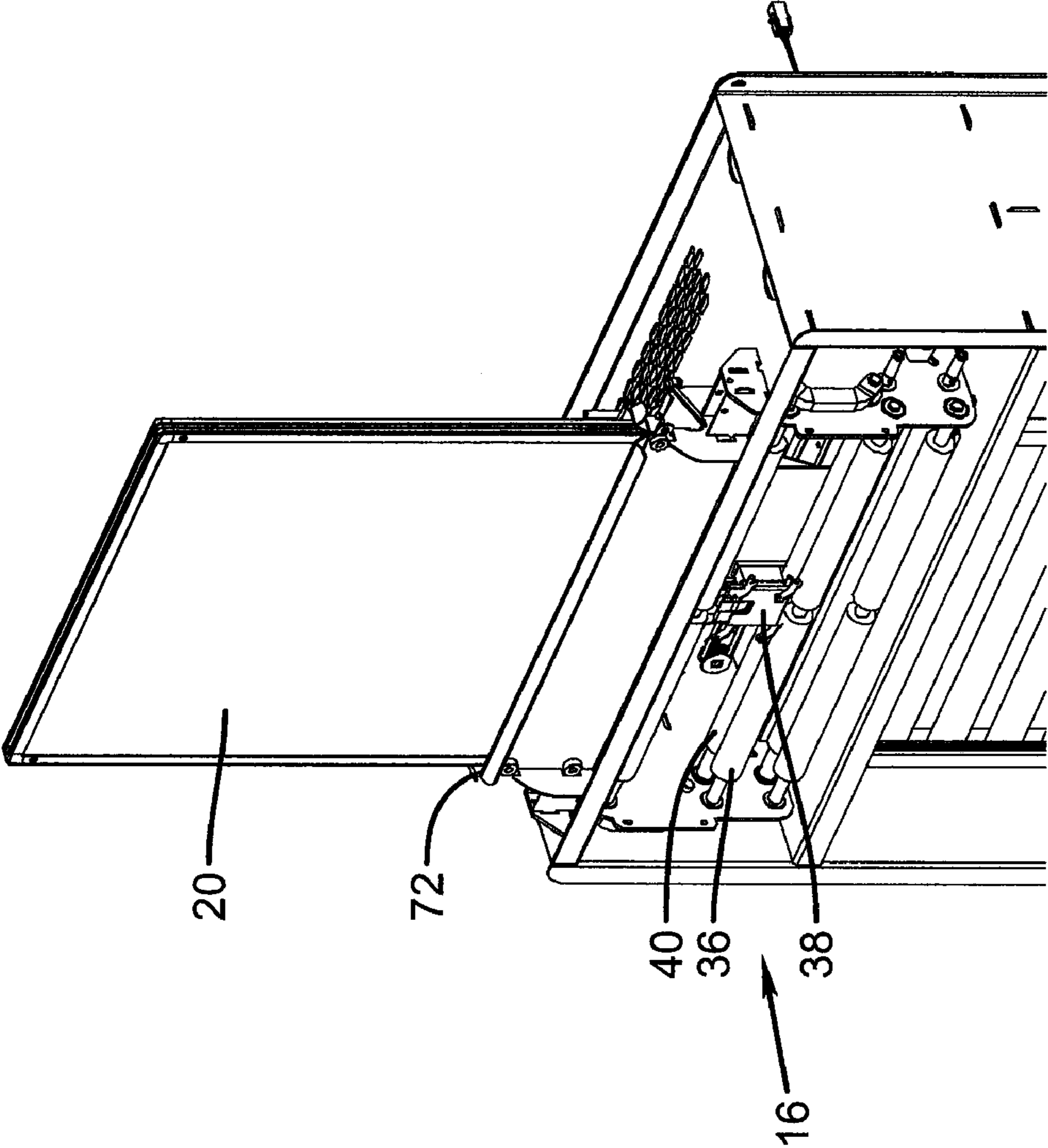
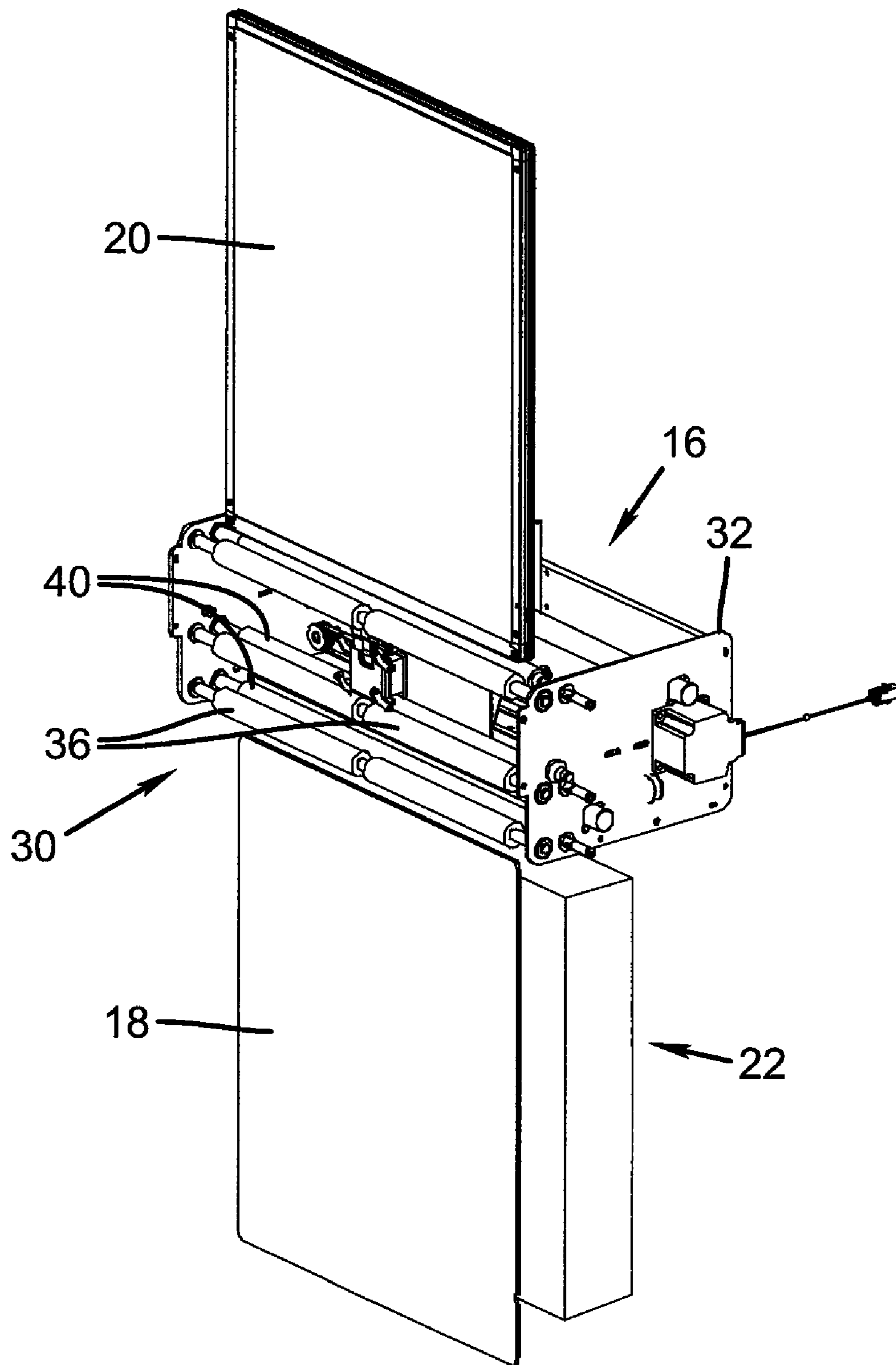
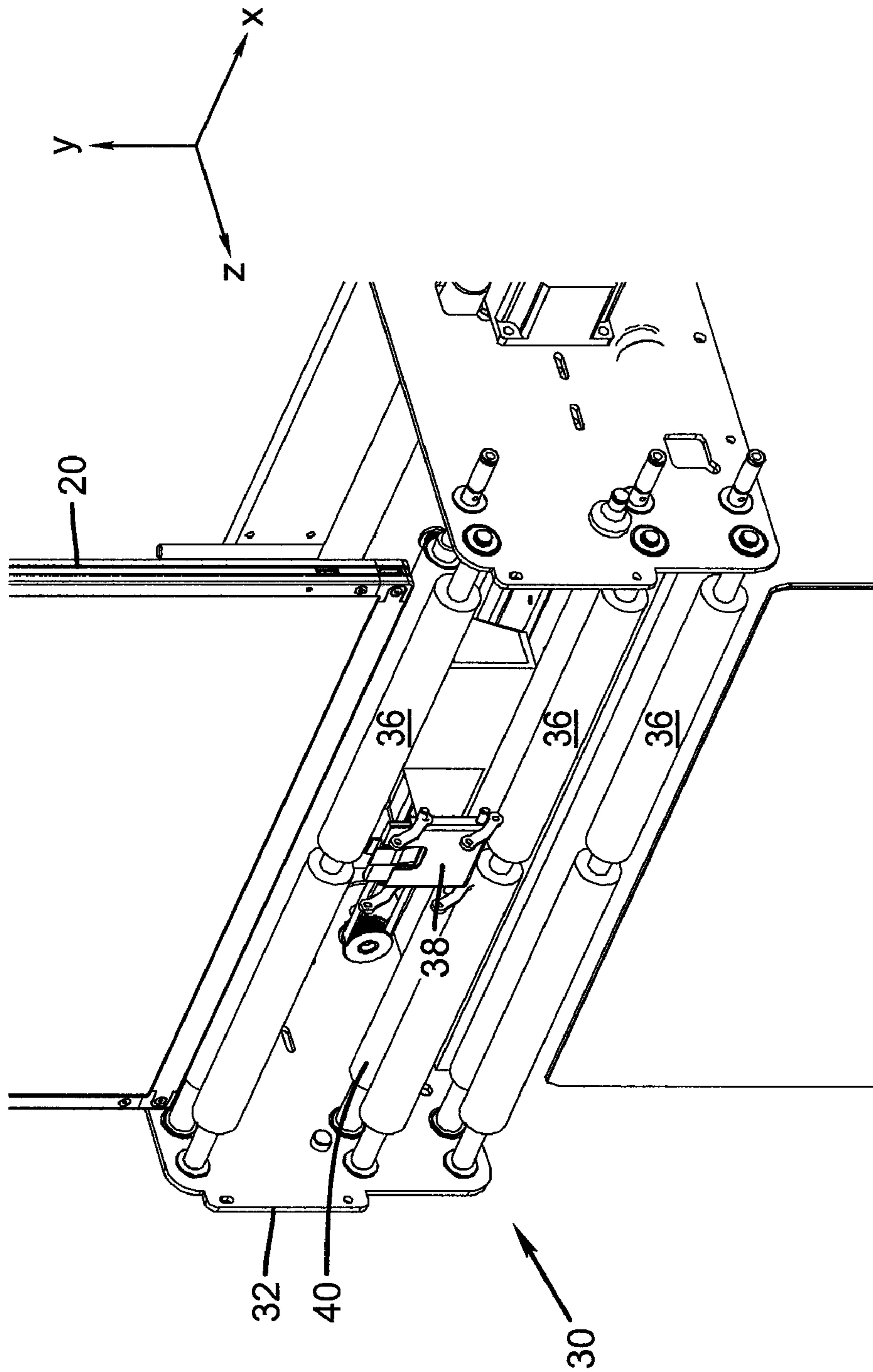


FIG. 6

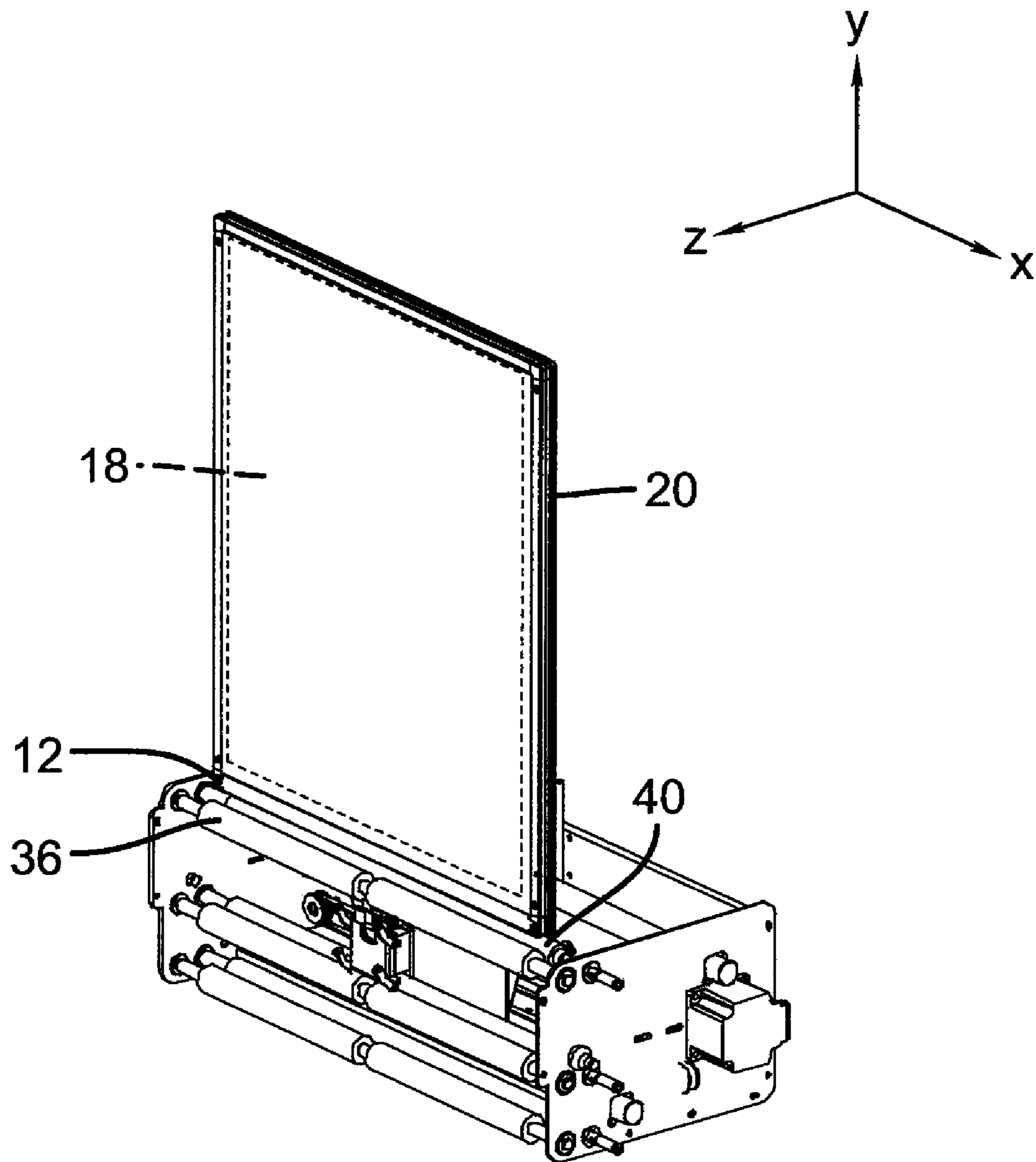


**FIG. 7**

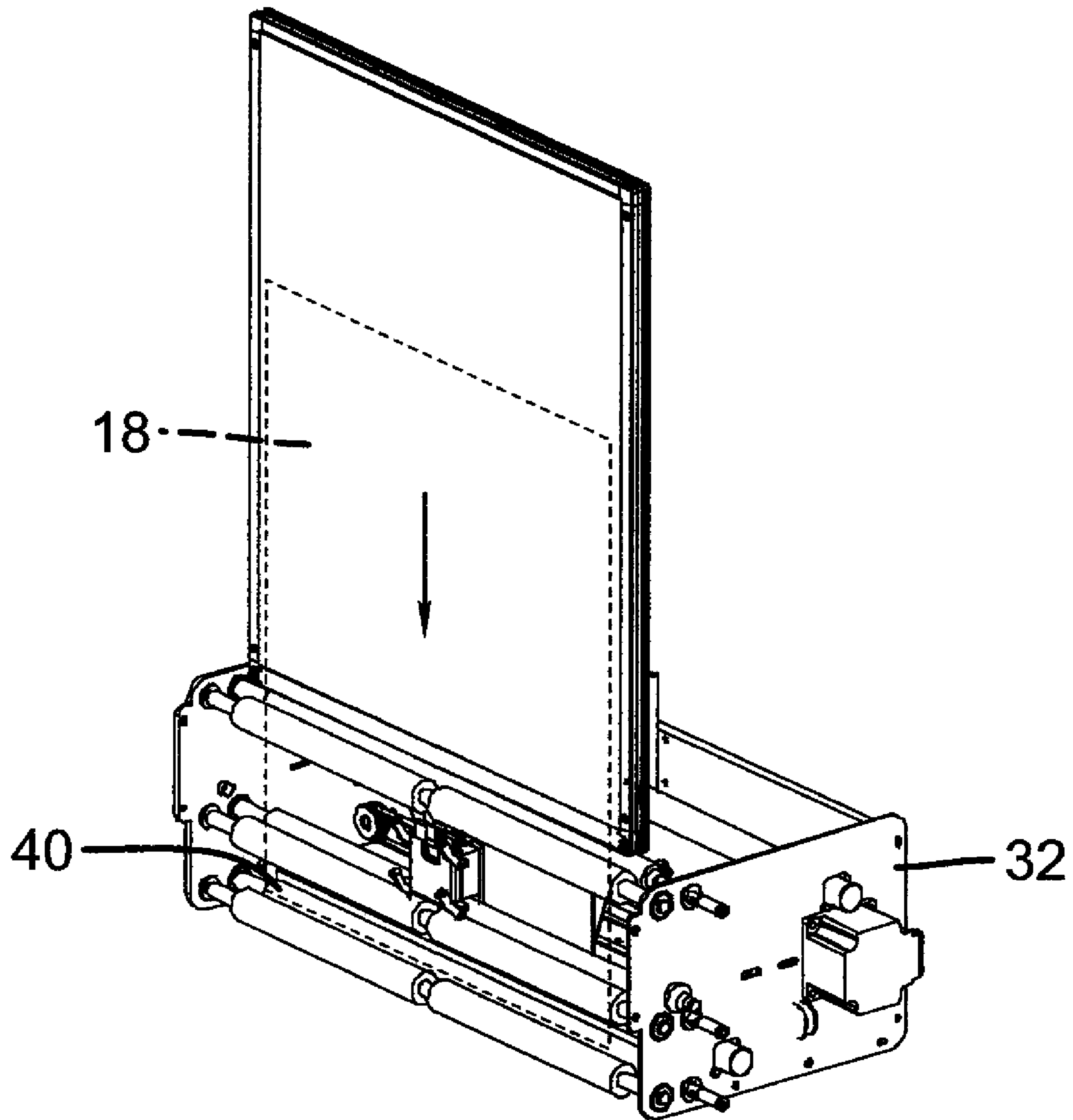




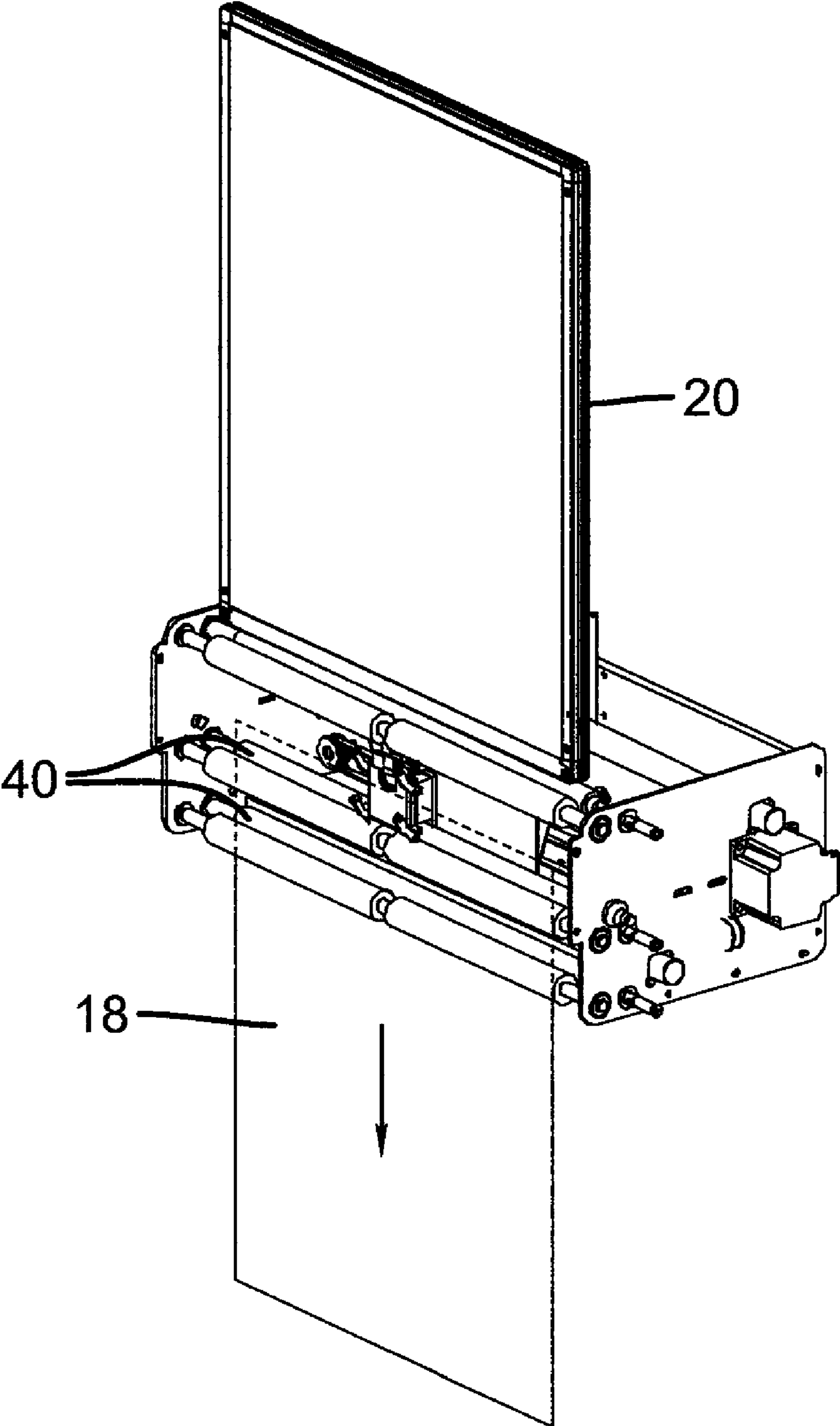
**FIG. 8**



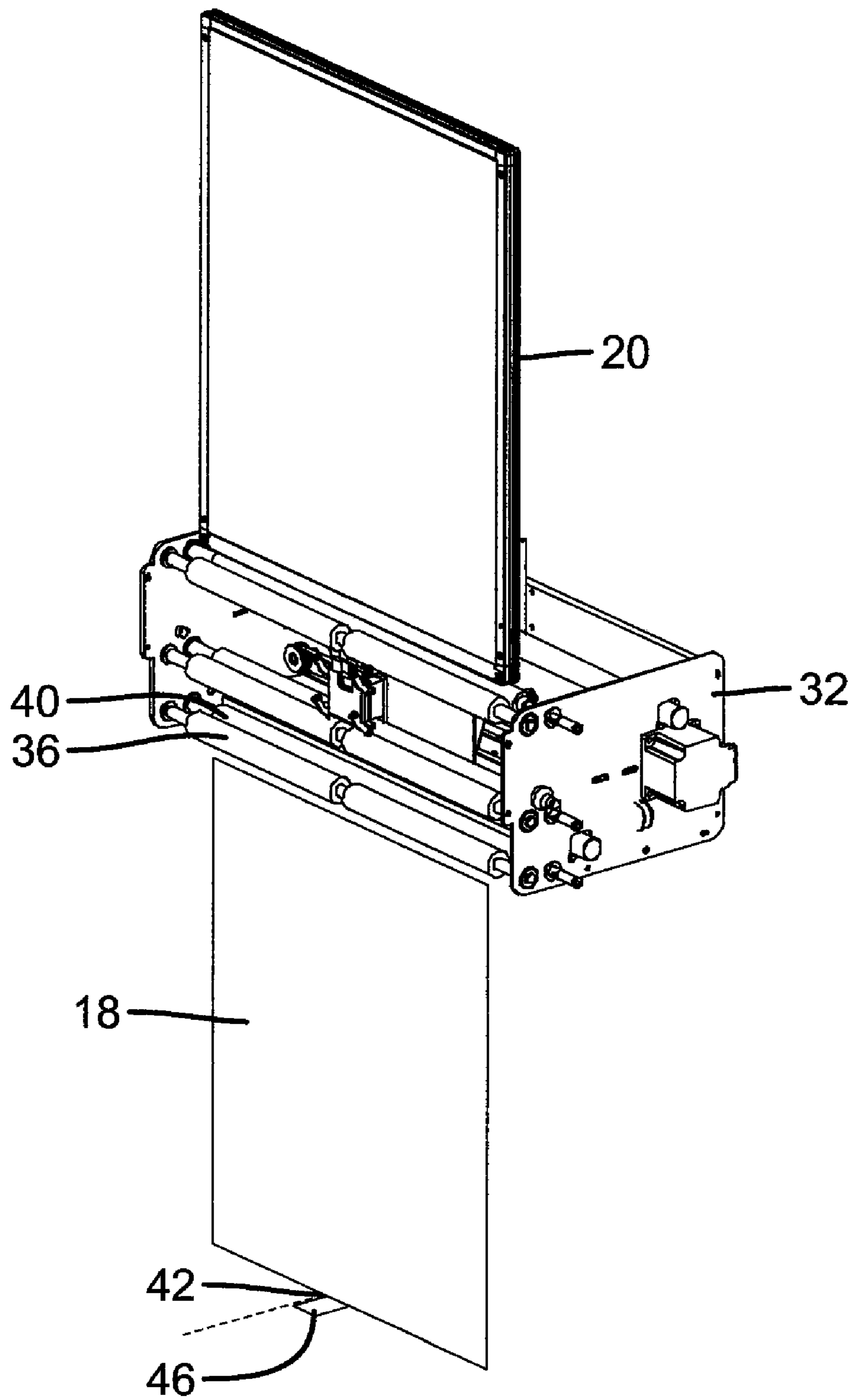
**FIG. 9A**



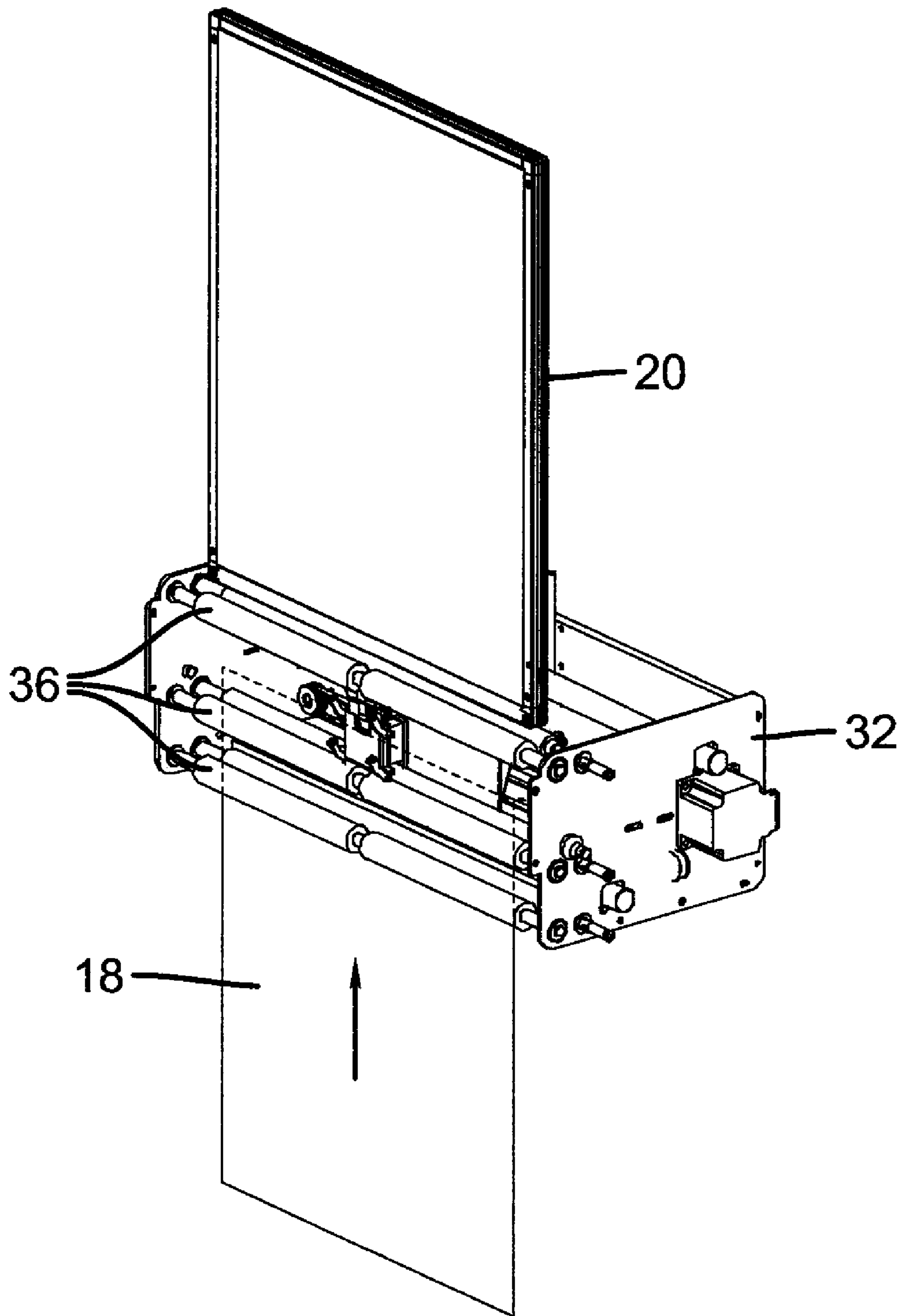
**FIG. 9B**



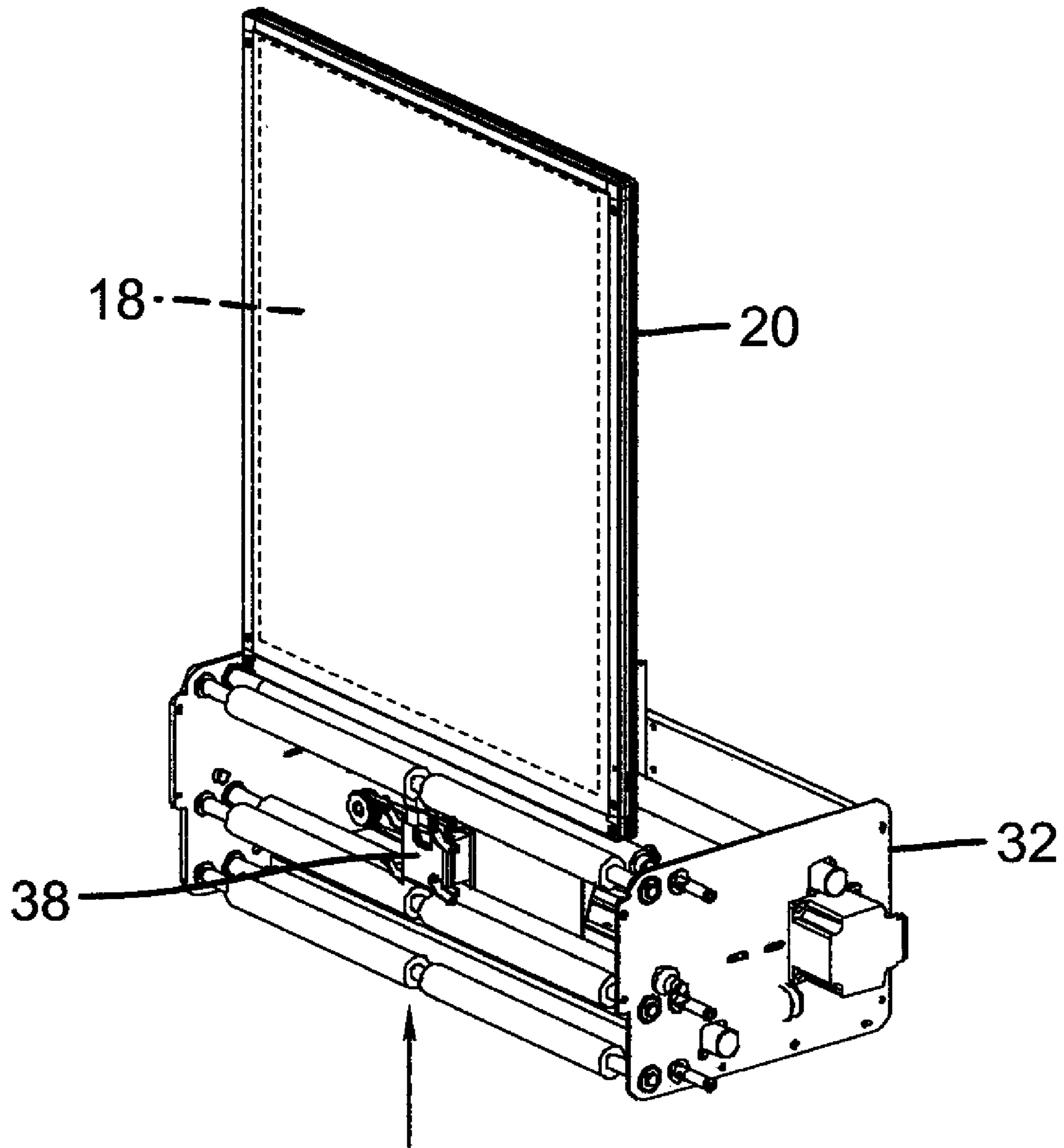
**FIG. 9C**



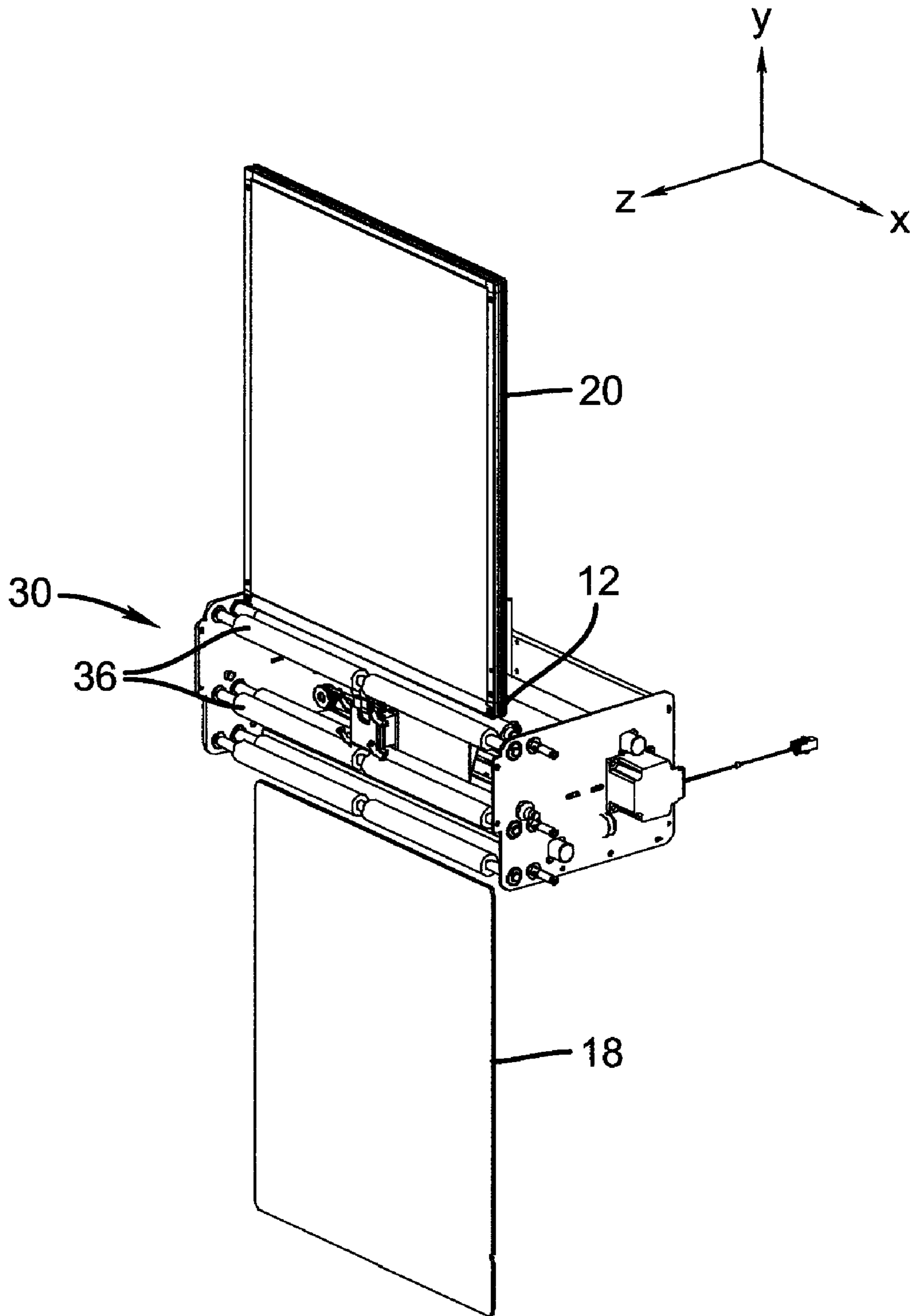
**FIG. 9D**



**FIG. 9E**

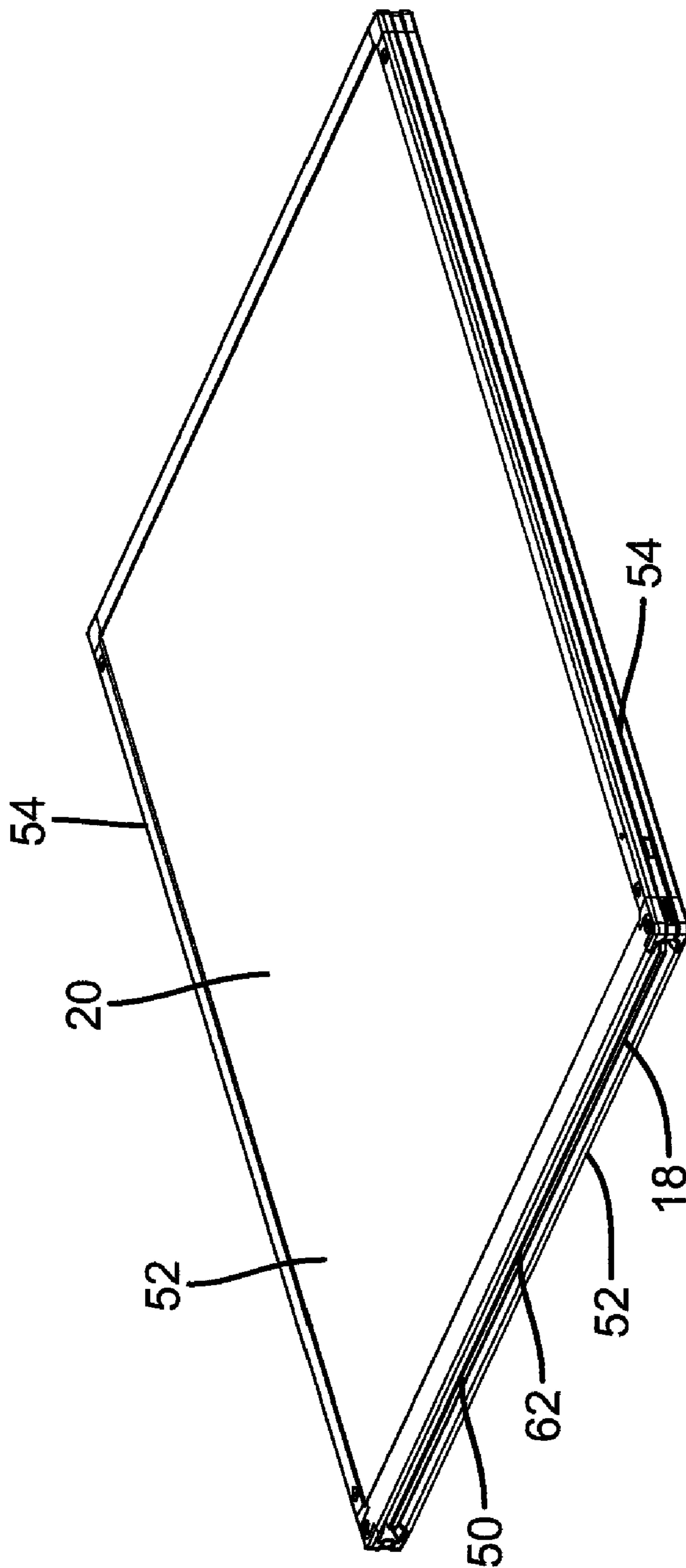


**FIG. 9F**

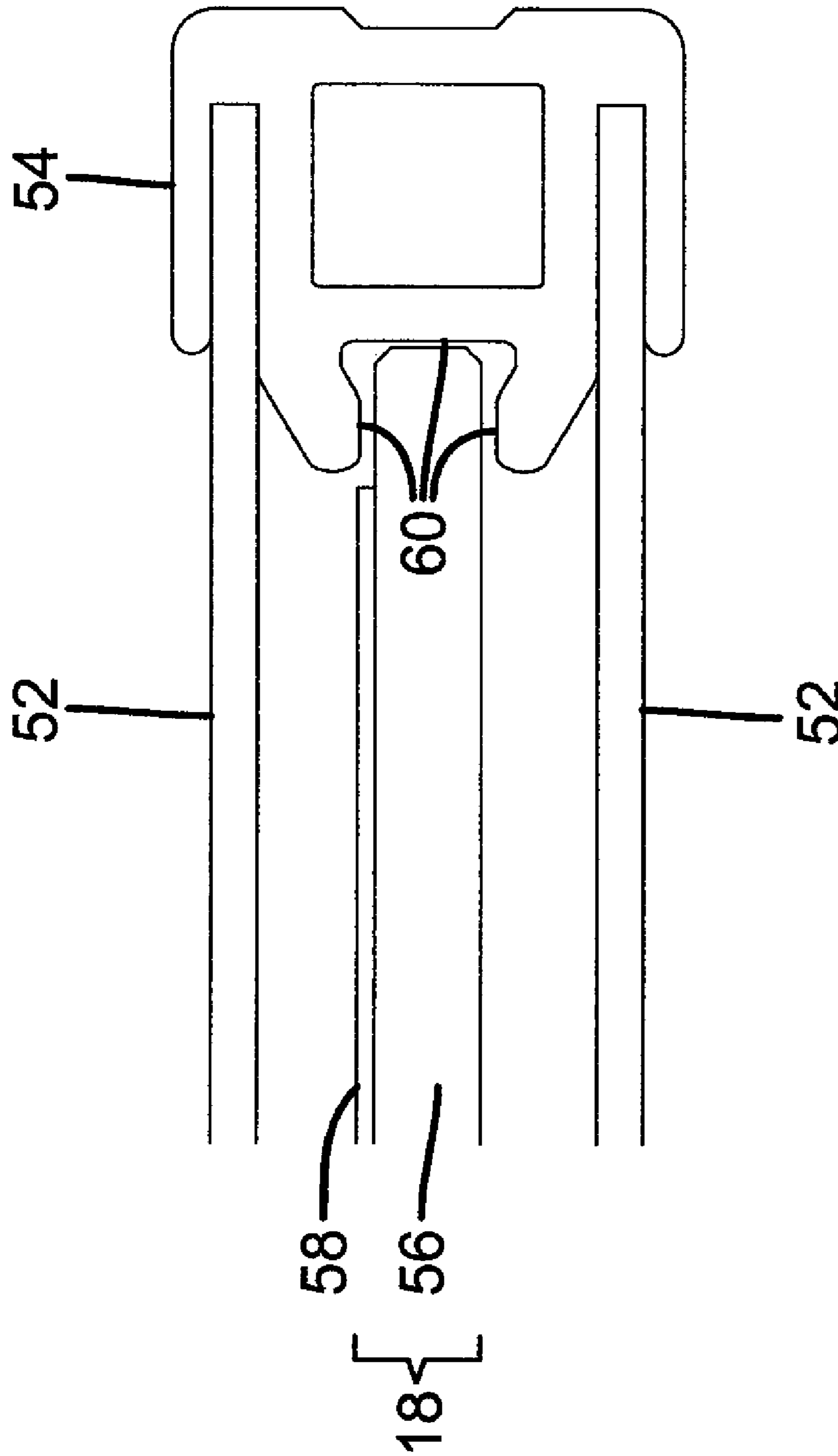


**FIG. 10**

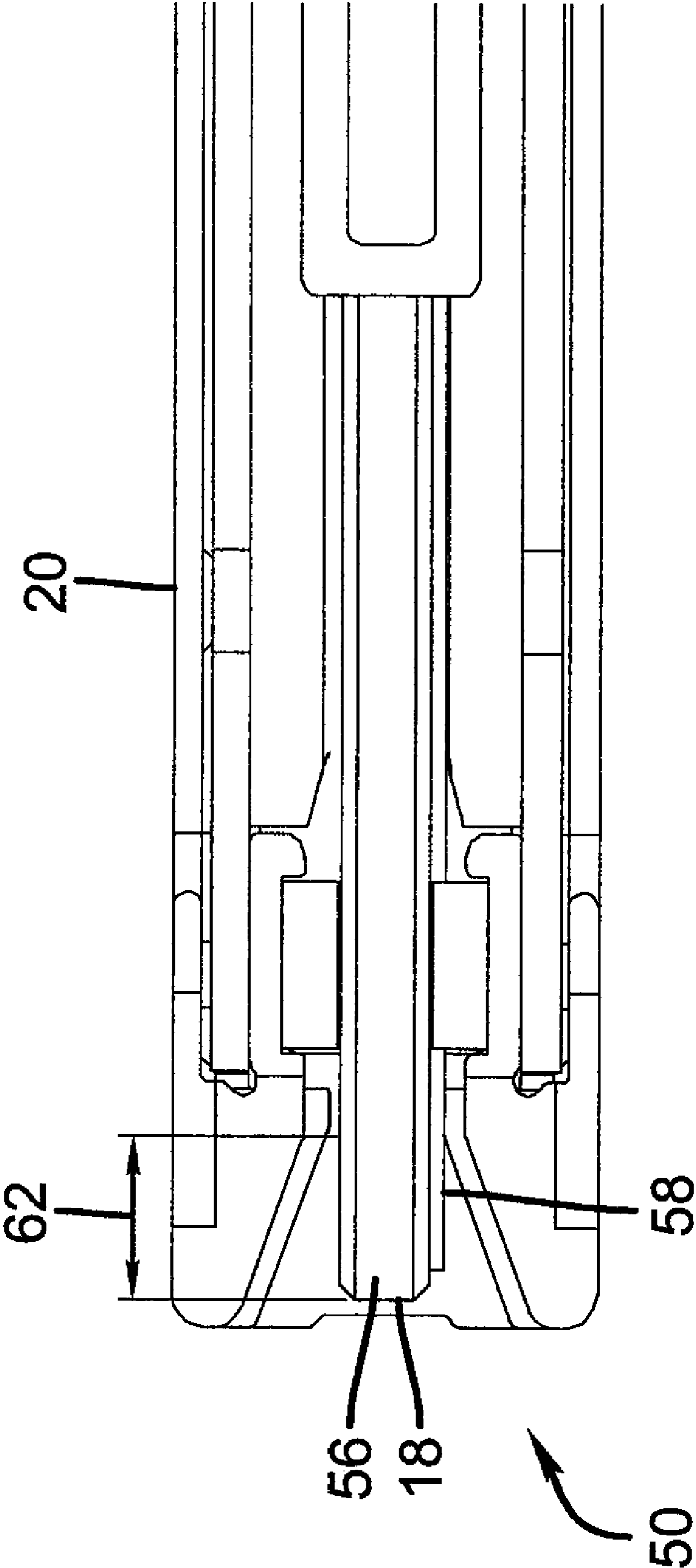




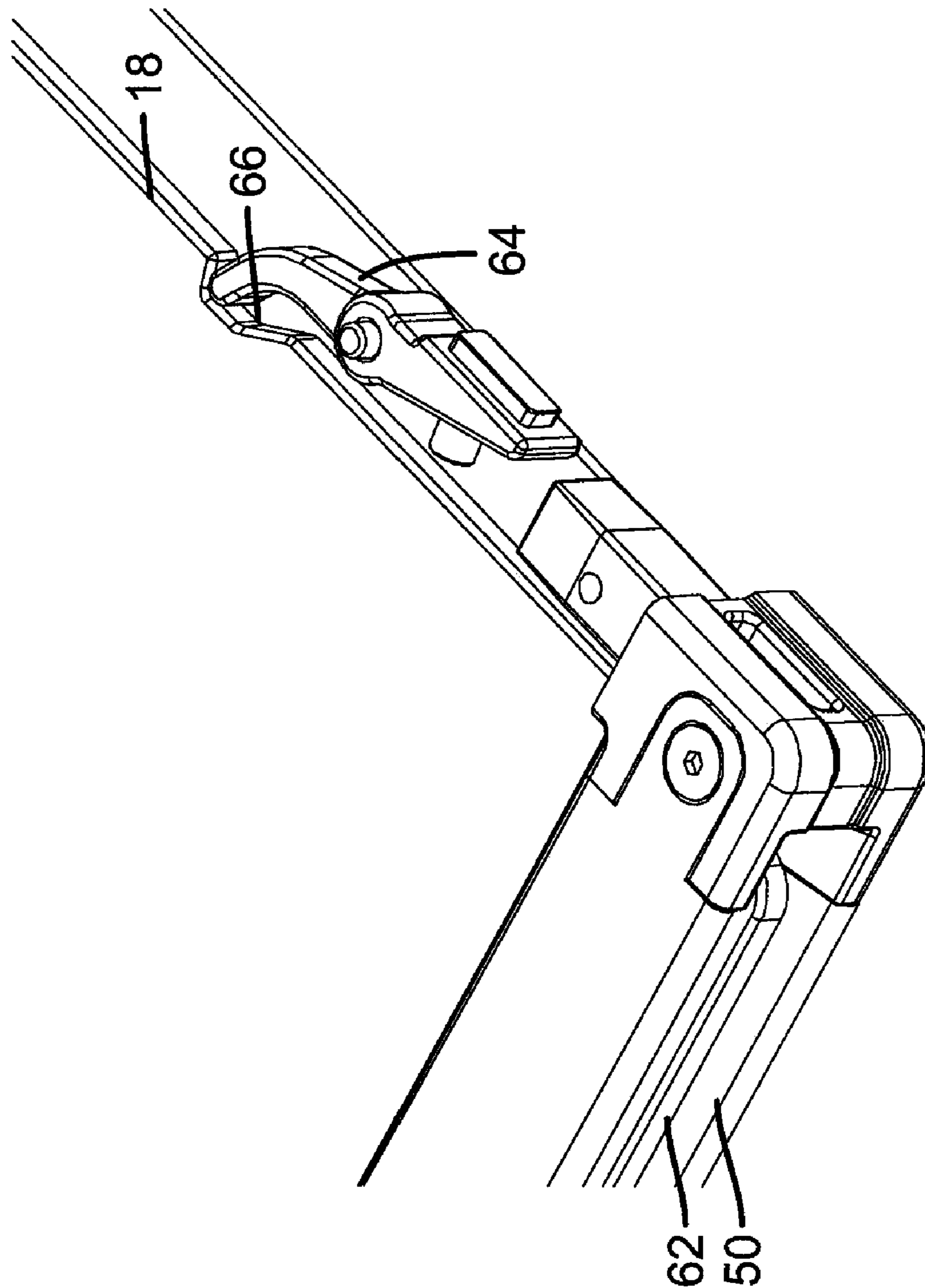
**FIG. 11**



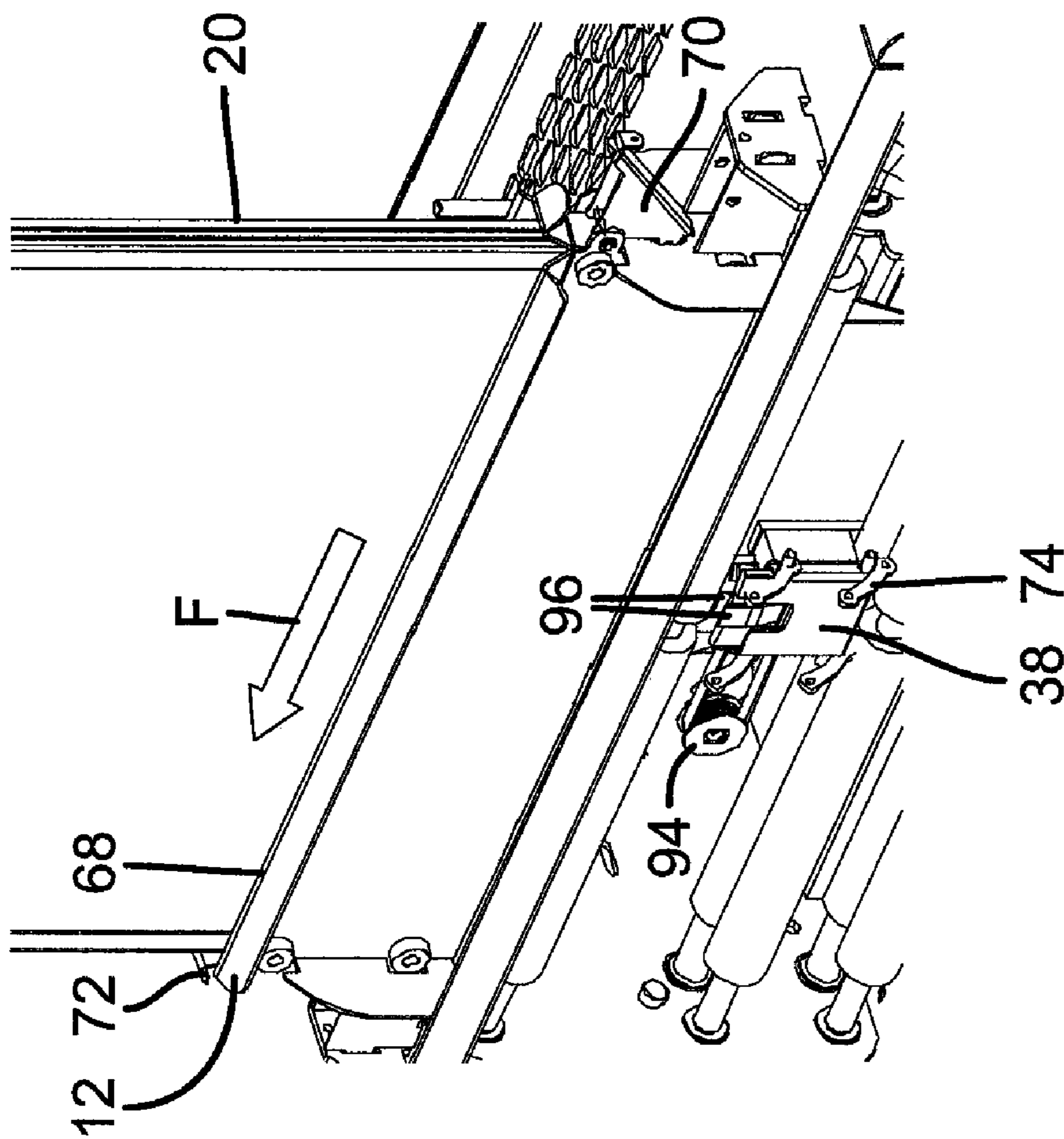
**FIG. 12A**



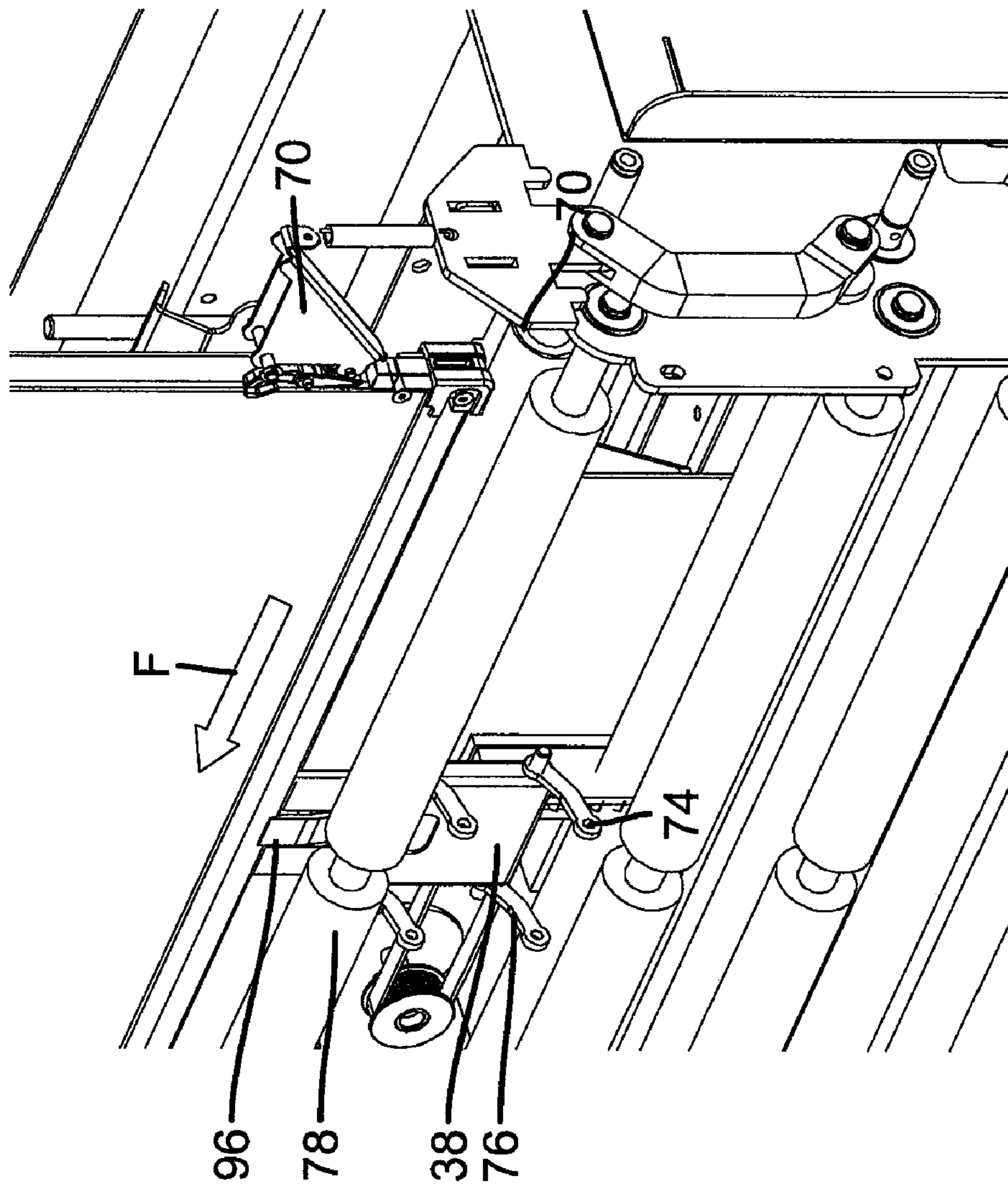
**FIG. 12B**



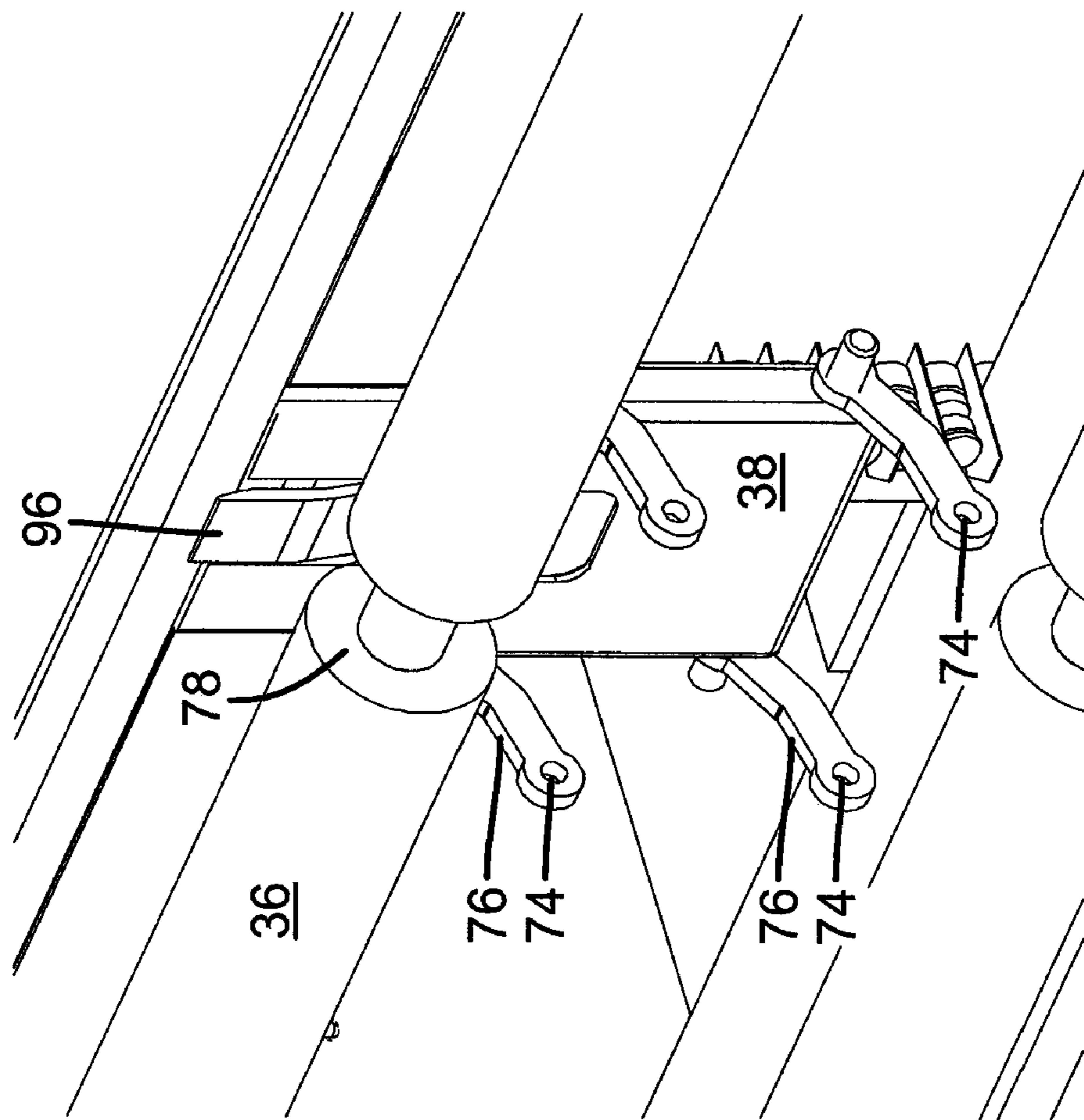
**FIG. 13**



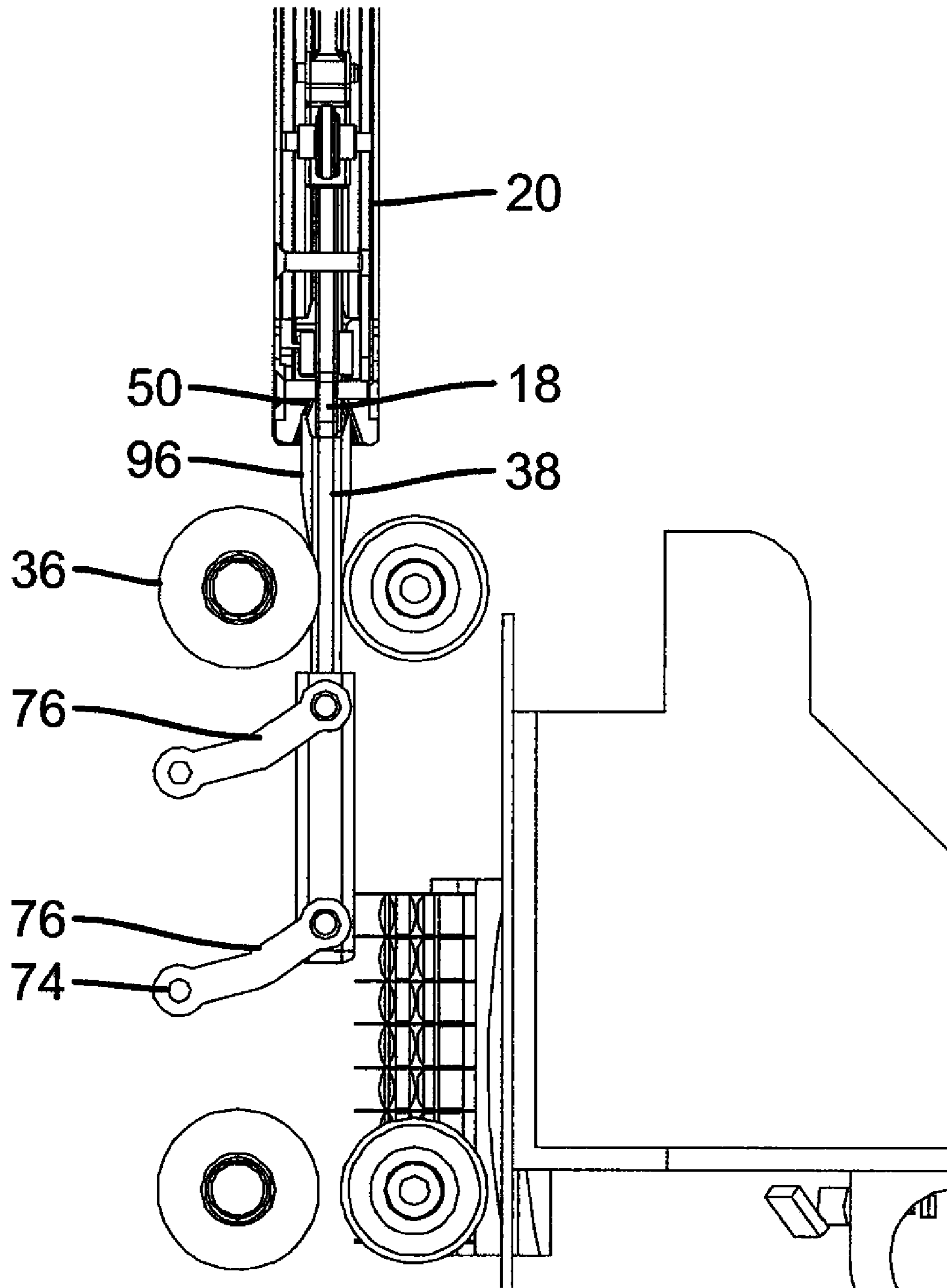
**FIG. 14A**



**FIG. 14B**



**FIG. 14C**



**FIG. 14D**



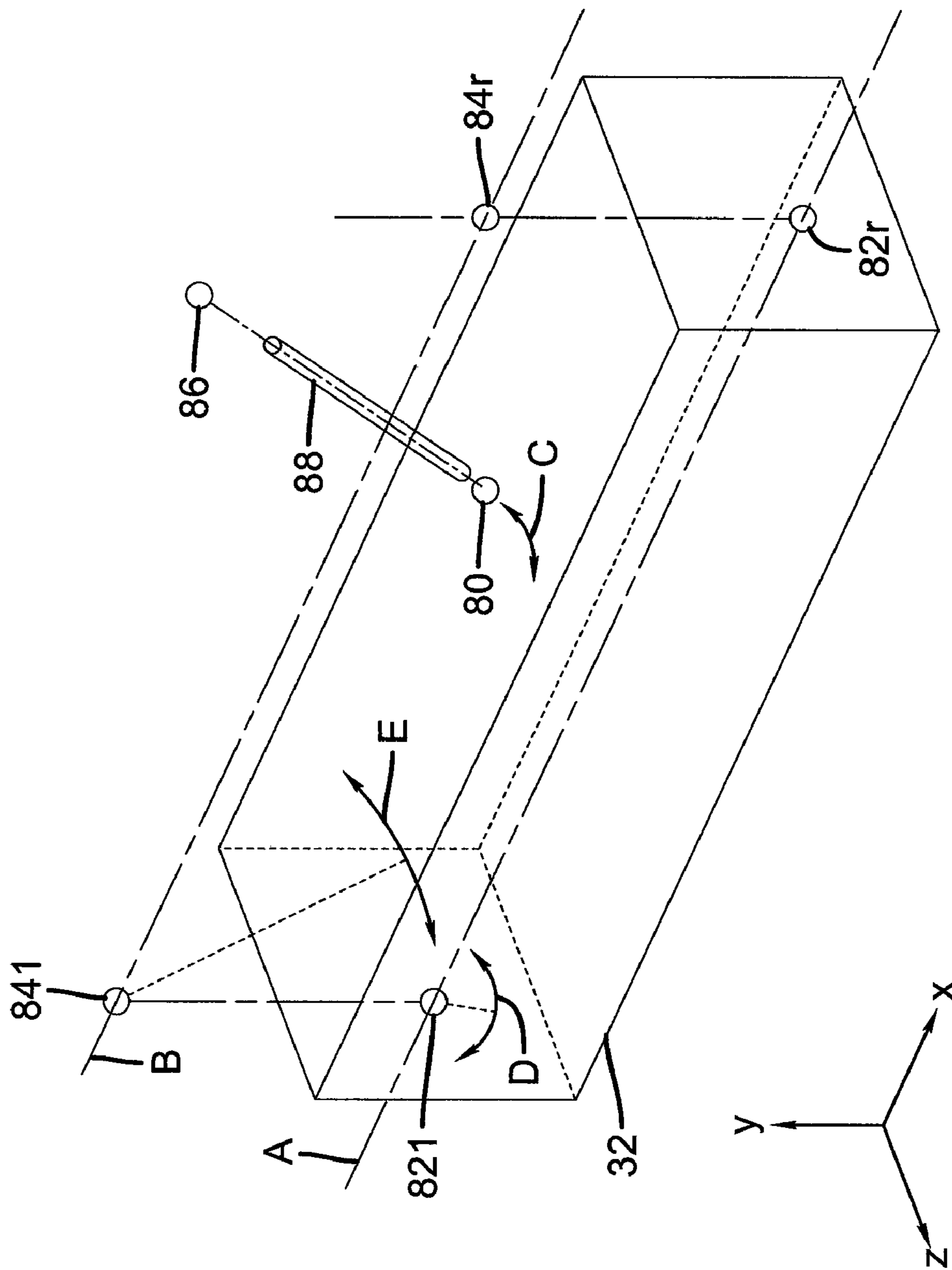
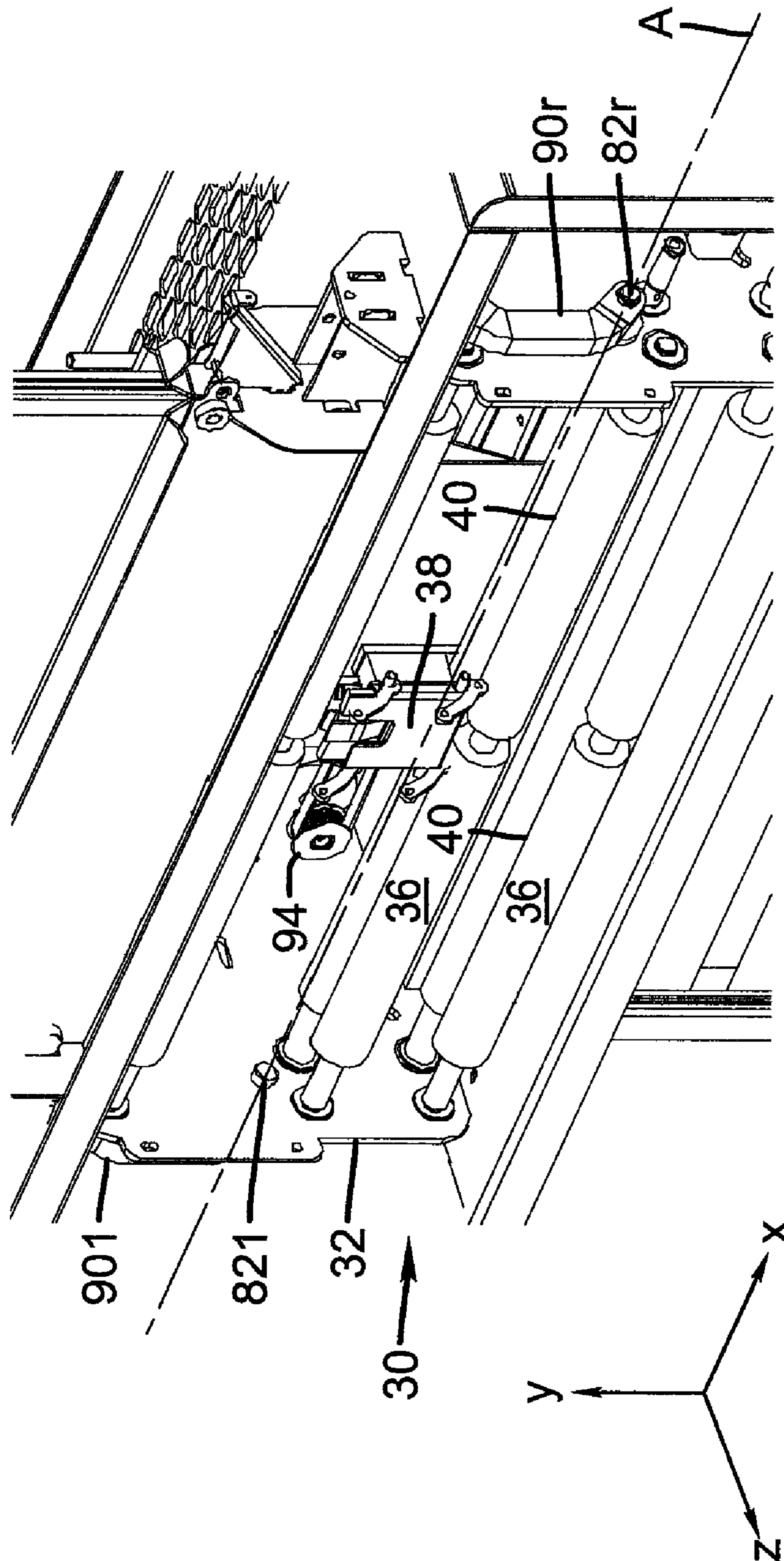
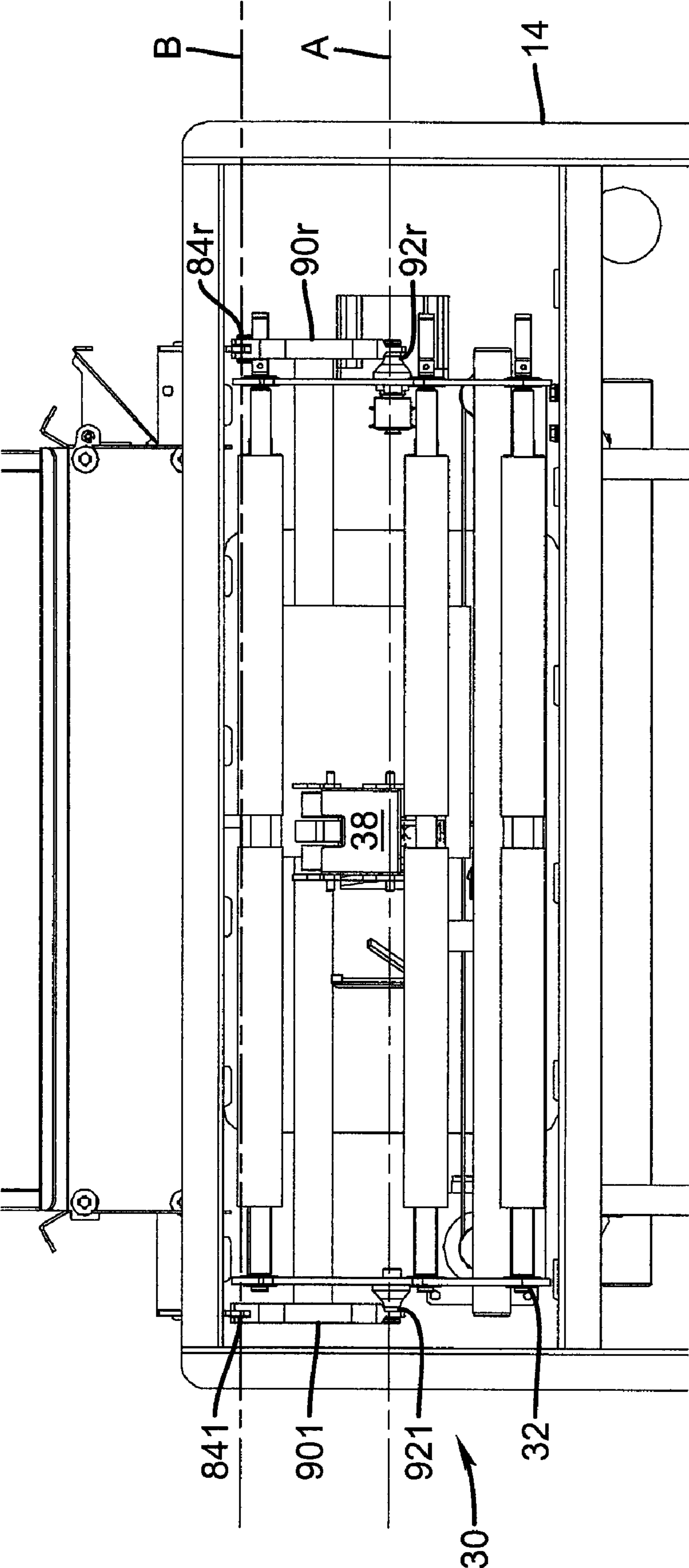


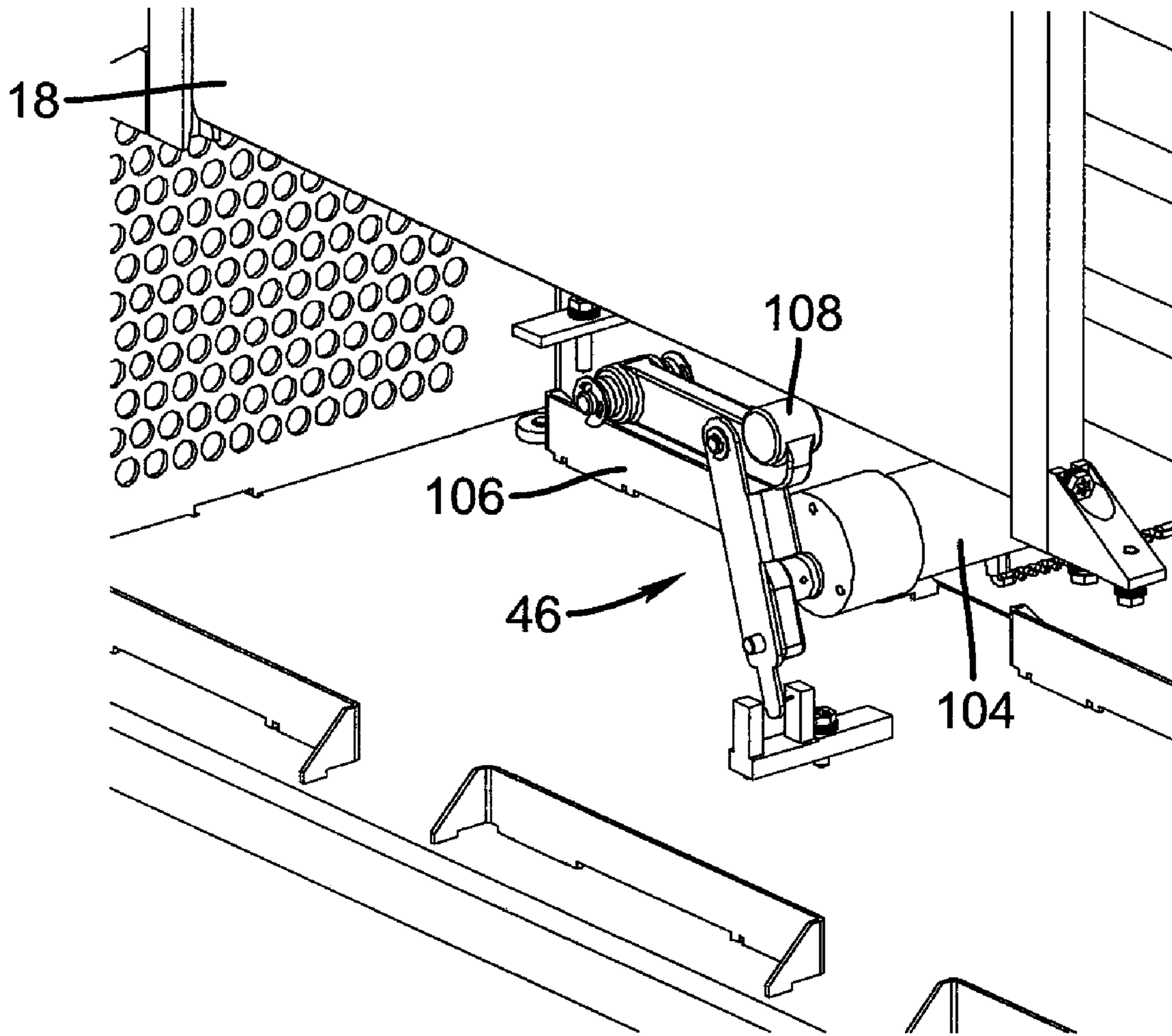
FIG. 15



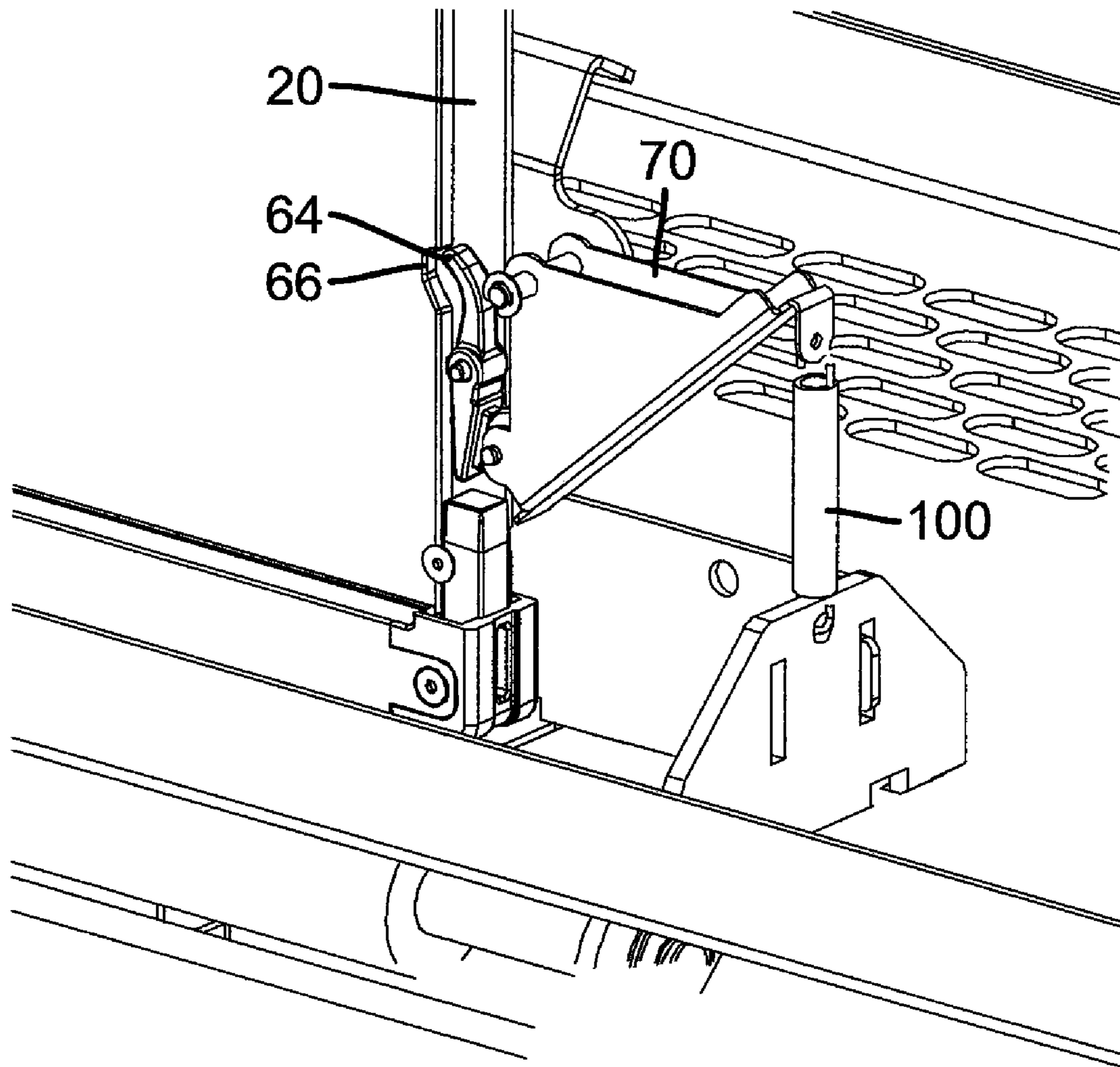
**FIG. 16**



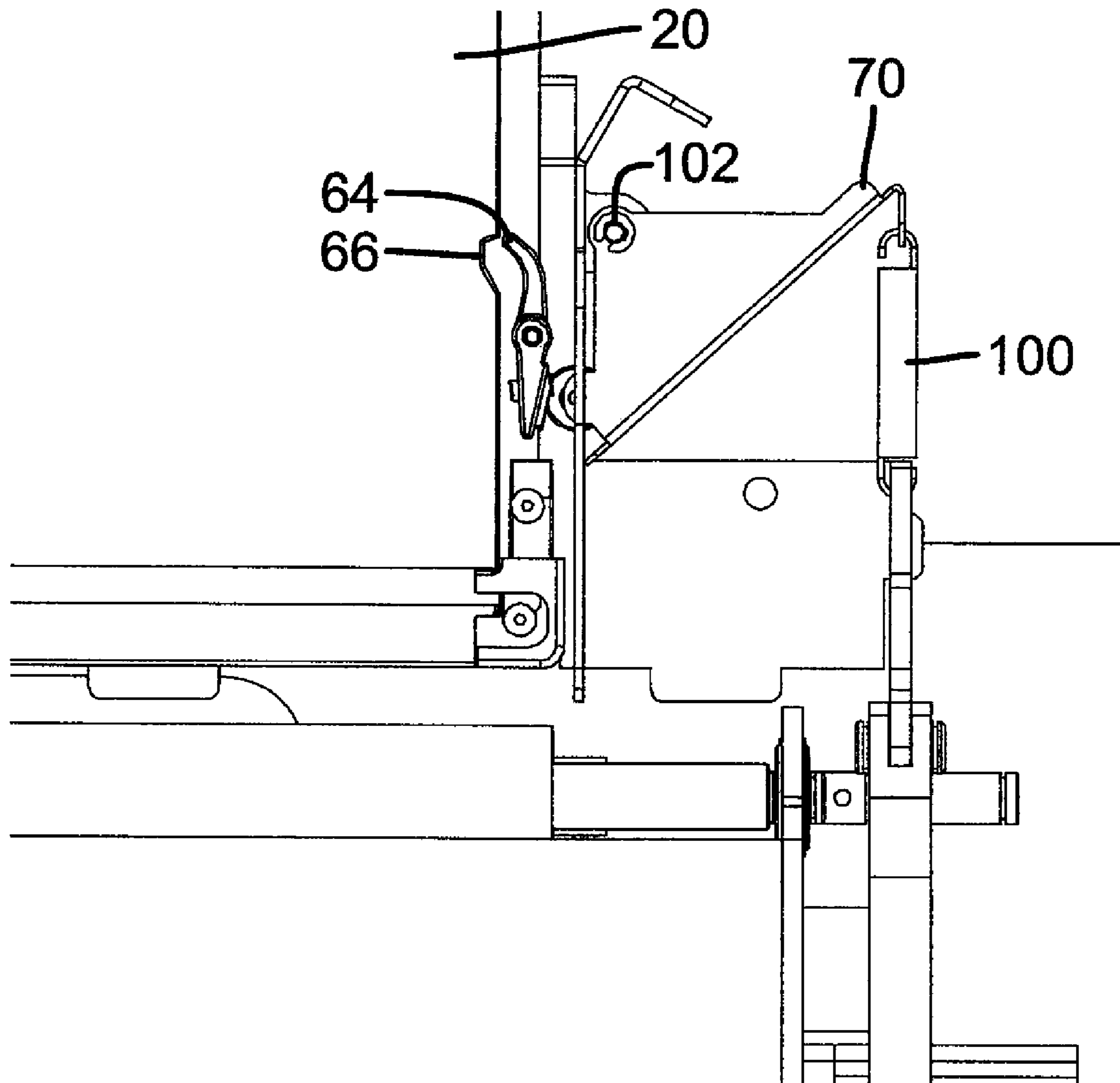
**FIG. 17**



**FIG. 18**



**FIG. 19**



**FIG. 20**

**RADIATION IMAGING CASSETTE**

## FIELD OF THE INVENTION

The invention generally relates to computed radiography, and in particular to an apparatus for scanning a stimu-  
5 phosphor medium having an exposed radiographic image formed thereon.

## BACKGROUND OF THE INVENTION

The field of computed radiography (CR) is well known. In computed radiography, x-rays are directed through a subject and onto a stimu-  
15 lable phosphor storage medium that stores a resulting image. The stimu-  
lable phosphor medium is subsequently provided to a scanning/reader apparatus, where the stimu-  
lable phosphor medium is stimulated to emit a radiation pattern that is indicative of the image formed by the x-rays. Advantageously, the stimu-  
20 lable phosphor medium can be erased and re-used.

In one arrangement of the stimu-  
25 lable phosphor storage medium, the stimu-  
lable phosphor medium is a flexible sheet suitable for transport through a scanning apparatus. For example, U.S. Pat. No. 6,770,900 (Minagawa) entitled "Mechanical [Apparatus] for Discharging Sheet-Like Mem-  
ber Container" describes an apparatus that guides a flexible sheet from a cassette and past a scan head and erasure appa-  
30 ratus, returning the erased flexible sheet into the cassette. U.S. Pat. No. 5,265,865 entitled "Stimu-  
lable Phosphor Sheet Feeding and Storing Mechanism and Stimu-  
lable Phosphor Sheet Cassette" (Agano) describes a scanning apparatus for automating the reading function and a cassette mechanism that holds the stimu-  
lable phosphor sheet during imaging, shipment, or storage.

An alternative arrangement to the flexible sheet is a com-  
35 puted radiography medium formed from a rigid sheet/plate. A rigid stimu-  
lable phosphor storage medium has advantages over flexible sheets, including durability and ease of handling. As a further benefit, a rigid substrate works well for needle phosphors, advantaged over other phosphor shapes in digital radiography for its imaging characteristics. Rigid stimu-  
40 lable phosphor storage media is described in U.S. Pat. No. 6,784,448 (Neriishi) entitled "Method for Reading Radiation Image from Stimu-  
lable Phosphor Sheet" which describes a scanning apparatus and method employing a rigid sheet. Commonly assigned U.S. Pat. No. 6,437,359 (Hall) entitled "CR Reader with Vertical Scanning" describes using a vertical travel path for directing a stimu-  
45 lable phosphor medium past scanning and erasure components. Commonly assigned U.S. Pat. No. 6,683,315 (Wendlandt) entitled "Storage Phosphor Cassette" and U.S. Pat. No. 5,276,333 (Robertson) entitled "X-Ray Cassette Having Removable Photo-  
graphic Element" describes embodiments of cassette apparatus for a rigid stimu-  
lable phosphor sheet.

An advantage of the rigid stimu-  
50 lable phosphor medium relates to the "footprint" or area required by the reader appa-  
ratus for scanning the rigid medium in automated fashion. One example proposed for minimizing footprint is given in U.S. Pat. No. 6,949,759 (Yonekawa) entitled "Radiographic Image Reading Apparatus", which describes a pivoting feed and registration mechanism with complex mechanisms for internal handling of the rigid stimu-  
lable phosphor medium.

Apparatus have been investigated for providing automated scanning and processing of rigid stimu-  
55 lable phosphor medium, however, cost and mechanical complexity can be significant drawbacks. Accurate registration of the scanning apparatus to the imaged stimu-  
lable phosphor medium needs

to be maintained. Even where a straightforward transport path is maintained for handling the stimu-  
60 lable phosphor medium, it can be difficult to maintain proper registration of the scanning apparatus to the stimu-  
lable medium without adding cost and complexity.

Accordingly, it is desired to provide a cassette for use with an scanning apparatus which provides accurate scanning reg-  
65 istration, reduces the footprint, and is relatively low cost.

## SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided a radiation imaging cassette. The cassette includes a housing, a latch member, and guide edges. The housing is adapted to house a stimu-  
70 lable phosphor sheet. The housing includes a light-protected region and an opening for extrac-  
tion and/or insertion of the stimu-  
lable phosphor sheet. The latch member releasably engages the stimu-  
75 lable phosphor sheet to secure at least a portion of the stimu-  
lable phosphor sheet within the light-protected region. The edge guides are disposed within the housing and operate to guide movement of the stimu-  
80 lable phosphor sheet through the opening.

These and other objects, features, and advantages of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings wherein there is shown and described an illustrative embodiment of the inven-  
85 tion.

## BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the present invention, it is believed that the invention will be better understood from the following description when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 shows a side view of a radiation image data reading apparatus according to the present invention.

FIG. 2 is a side view of the radiation image data reading apparatus showing internal subsystems and components.

FIG. 3 is a perspective view of the radiation image data reading apparatus with cover removed.

FIG. 4 is a front view of the radiation image data reading apparatus components.

FIG. 5 is a close up view showing key components of the transport section and its associated scanning section.

FIG. 6 is a perspective view showing cassette handling components.

FIG. 7 is a perspective view showing the substantially vertical transport path for the stimu-  
80 lable phosphor sheet.

FIG. 8 is a close-up perspective view of transport section components.

FIGS. 9A through 9F show the sequence of handling for the stimu-  
85 lable phosphor sheet.

FIG. 10 shows edge registration along the transport path.

FIG. 11 is a perspective view showing the cassette.

FIG. 12A is a cross sectional view of a portion of the cassette showing edge guidance features.

FIG. 12B is a cross sectional view, taken orthogonally with respect to FIG. 12A, showing the leading edge of the phosphor sheet in the cassette.

FIG. 13 is a close-up perspective view showing the cassette latching mechanism.

FIG. 14A is a close-up perspective view showing the cassette sheet return mechanism.

FIG. 14B is a close-up perspective view showing the cassette sheet return mechanism at one stage of actuation.

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FIG. 14C is a close-up perspective view showing sheet return member 38 and support components when actuated.

FIG. 14D is a close-up side view showing sheet return member 38 and support components when actuated.

FIG. 15 is a schematic view showing key aspects of gimbaled mounting for scanning and transport components.

FIG. 16 is a perspective view showing components used for gimbaled mounting.

FIG. 17 is a front view showing components used for gimbaled mounting of the scanning section.

FIG. 18 is a close-up perspective view of an urging mechanism for reversing sheet direction according to one embodiment.

FIG. 19 is a close-up perspective view of a mechanism for sheet release from the cassette in one embodiment.

FIG. 20 is a side view of the cassette sheet release mechanism.

#### DETAILED DESCRIPTION OF THE INVENTION

The present description is directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art.

Reference is made to commonly assigned application U.S. Ser. No. 11/507,348, entitled "APPARATUS FOR SCANNING STIMULABLE PHOSPHOR MEDIUM", and filed on common date in the names of Urbon et al., and which is assigned to the assignee of this application.

Reference is made to commonly assigned application U.S. Ser. No. 11/507,233, entitled "A SHEET SCANNING APPARATUS", and filed on common date in the names of Urbon et al., and which is assigned to the assignee of this application.

It is noted that a "rigid" or "semi-rigid" phosphor sheet relate to substrate media, and may be of particular use with needle phosphors. Some CR systems use a flexible phosphor sheet. The rigidity or stiffness of a sheet is conventionally characterized as the product of its elastic modulus  $E$  and the cubed value of the sheet thickness  $t$ , that is:  $Et^3$

As a guideline, a sheet that would be considered at least semi-rigid in this application would have a modulus of elasticity  $E$  of at least 500,000 psi and thickness  $t$  ranging from about  $t=0.02$  to about  $t=0.5$  inches.

Referring to FIG. 1, there is shown, in side view, a radiation data reading apparatus 10 according to the present invention. Radiation data reading apparatus 10 reads a radiographic image that has been obtained using an x-ray system (not shown) and has been stored on a stimuable phosphor medium that is housed within a cassette 20. Cassette 20 is designed to seat in a receiving/loading section 12 that includes the components to extract the stimuable phosphor medium from cassette 20 and restore it into position once a scanning and an erasure process are complete. Scanning and erasure components are housed in a housing/chassis 14.

The side view of FIG. 2 shows internal subsystems of radiation data reading apparatus 10, including a substantially vertical transport path that a rigid or semi-rigid stimuable phosphor sheet 18 follows from cassette loading section 12 through portions of chassis 14.

The internal subsystems include a scanning section 16, a transport section 30, and an erase section 22. Scanning section 16 includes optics, stimulating radiation, and detector components for obtaining the image stored on stimuable phosphor sheet 18. Transport section 30, which can be actuated by one or more drive motor(s) 44, guides stimuable phosphor sheet 18 past scanning section 16 and into erase

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section 22. Erase section 22 includes one or more erasure radiation sources 24, typically arranged as a bank of lights, as shown in FIG. 2. Transport section 30 is mechanically coupled to scanning section 16 and cooperates with scanning section 16 to provide precision registration to move stimuable phosphor sheet 18.

A power supply 26 and control electronics section 28 provide the power and control signals needed to obtain the image and handle the scanning, erasure, and return of stimuable phosphor sheet 18 into cassette 20. Arrows in FIG. 2 indicate the flow of cooling air provided by a fan 98.

FIG. 3 shows a perspective view, with portions of chassis 14 removed to illustrate underlying parts of radiation data reading apparatus 10, including scanning section 16. Scanning section 16 includes a scan housing 32 that encloses an optical scanning apparatus 34, indicated in dotted outline in FIG. 3, and supports components of transport section 30, as described subsequently.

Optical scanning apparatus 34 are known to those skilled in the art, and can be, for example, a flying-spot scanner that directs a scanned laser light onto stimuable phosphor sheet 18 as an excitation light, then reads the excited light that results to obtain the previously stored image therefrom. Optionally, optical scanning apparatus 34 can be a swath scanning apparatus that uses an excitation source and a photosensor array for obtaining the stored image, one horizontal swath at a time. The apparatus of the present invention is well-suited to operation with a number of optical scanning components that direct excitation energy of a first wavelength onto the phosphor sheet 18 and obtain phosphorescent light excited thereby, as is well known to those skilled, in the digital radiographic imaging arts.

FIG. 3 also shows a transport roller 36 that is part of transport section 30 and is used, in conjunction with other components as described subsequently, to move stimuable phosphor sheet 18 through scanning section 16 and, following scanning, into erase section 22.

In an embodiment shown in FIG. 4, erase section 22 includes a bank of erasure radiation sources, such as would be provided by standard fluorescent lamps, for example a DULUX™ type bulb from Osram Sylvania, Danvers, Mass.

The view of FIG. 5 and rear perspective view of FIG. 6 show transport section 30. In this embodiment, three pairs of opposing rollers 36 are used for guiding stimuable phosphor sheet 18 through radiation data reading apparatus 10, each pair of rollers 36 forming a nip 40. With this arrangement, stimuable phosphor sheet 18 is stably secured between at least two nips 40 while it is being scanned. Rollers 36 are attached to scan housing 32, thereby providing registration along the optical axis (conventionally described as the z axis direction).

FIGS. 5 and 6 also show the position of a sheet return member 38 in one embodiment. Sheet return member 38 is actuated upon return of stimuable phosphor sheet 18 into cassette 20, in the cassette reloading sequence described subsequently.

#### Sheet Transport Sequence

The perspective view of FIGS. 7 and 8 show scanning section 16 with rollers 36 from transport section 30 mounted onto scan housing 32. This arrangement provides registration along the optical axis, shown as the z axis using the coordinate axes assignment of FIG. 8. The y axis is vertical, the x axis horizontal using this conventional axis assignment. The sequence given in FIGS. 9A through 9F shows how these components cooperate to transport stimuable phosphor sheet 18 along the vertical y axis through scanning section 16 and



erase section 22. Stimulable phosphor sheet 18 is shown in dotted outline where it is hidden from view.

FIG. 9A shows stimulable phosphor sheet 18 housed in cassette 20 as cassette 20 is received in cassette loading section 12. Components of cassette loading section 12, described subsequently, release stimulable phosphor sheet 18 from cassette 20 when cassette 20 is received in cassette loading section 12. Nip 40 of the first set of rollers 36 receives the leading edge of the released stimulable phosphor sheet 18 as it is removed from cassette 20. In one embodiment, control electronics section 28 (FIG. 2) detects this leading edge and actuates one or more drive motors 44 to turn rollers 36 for transporting stimulable phosphor sheet 18. In another embodiment, components of cassette loading section 12, as described subsequently, actuate a drive motor when cassette 20 is received in position in cassette loading section 12.

Referring next to FIG. 9B, scanning begins when stimulable phosphor sheet 18 has reached a scan position, for example, when sheet 18 reaches the second nip 40. In this arrangement, stimulable phosphor sheet 18 is positioned between at least two nips 40, and scan housing 32 is registered to stimulable phosphor sheet 18. As such, a portion of sheet 18 (adjacent the leading edge of the stimulable phosphor sheet) is not used for image storage but rather serves to facilitate handling of the sheet. In one embodiment, for example, the non-imaged lead edge portion of stimulable phosphor sheet 18 is nominally about 0.5 inches, preferably at least more than about 0.25 inches in length.

FIG. 9C shows stimulable phosphor sheet 18 at a position near the end of scanning. The sheet can be accurately scanned when held between two nips 40 as shown. As shown in FIG. 9D, stimulable phosphor sheet 18 reaches an end point 42 of travel, indicated along a dotted line in this figure. At this stage of processing, stimulable phosphor sheet 18 is within erase section 22 as was shown in FIGS. 2 through 4, and erasure of the sheet can be conducted. After erase exposure is completed, an urging mechanism 46 is actuated, wherein the direction of stimulable phosphor sheet 18 is reversed and sheet 18 is moved into nip 40 of the lower set of rollers 36. Motor 44, or its supporting gear mechanism (not shown), reverses the direction of rollers 36. Urging mechanism 46 can be a cam-actuated arm in one embodiment or alternately a solenoid or other actuator known to those skilled in the art.

Urging mechanism 46 can be configured to align sheet 18 toward a plane substantially parallel to reference edge 72. As such, when sheet 18 is inserted into cassette 20 (during reinsertion), sheet 18 is urged toward reference edge 72. For example, as shown in FIG. 18, lifting arm 108 can be an urging-surface which moves along the x-axis edge of sheet 18 toward the plane substantially parallel to reference edge 72 thereby causing sheet 18 to slightly pivot and translate in the x-direction toward the plane substantially parallel to reference edge 72.

FIG. 9E shows stimulable phosphor sheet 18 moving through rollers 36 and into cassette 20. Edge guidance can be provided for guiding side edges of stimulable phosphor sheet 18 along its return path to promote sheet reinsertion into cassette 20 without binding or obstruction. FIG. 9F shows completion of the reinsertion sequence. Sheet return member 38 actuates to urge stimulable phosphor sheet 18 into cassette 20. Once the sheet is returned to the cassette, a latch mechanism can be engaged to secure the sheet within the cassette, as is described subsequently.

As was described with reference to FIG. 2, control electronics section 28 can provide the control logic and drive signals that coordinate movement of stimulable phosphor sheet 18 along its transport path. A minimum number of

sensors are needed to detect conditions such as end of travel, presence within at least two nips 40, and other events, as would be familiar to one skilled in the motion control arts.

Rollers 36 can be conventional paired rollers, for example, with rubber and foam rollers paired to form nip 40 which are preferably firm but not overly rigid. The rollers are employed to hold stimulable phosphor sheet 18 firmly, without causing it to fold, bend, or become warped.

FIGS. 14A through 14D show an embodiment of sheet return member 38. FIG. 14A shows sheet return member 38 in a resting or unused position. Upon sensing that stimulable phosphor sheet 18 is being reinserted into cassette 20, sheet return member 38 is actuated. The perspective views of FIGS. 14B and 14C and side view of FIG. 14D show sheet return member 38 in a actuated position. Members 96, shown as spread fingers 96, on sheet return member 38 are arranged to stabilize edge movement as sheet return member 38 urges the leading edge of stimulable phosphor sheet 18 upward toward cassette 20. A motor 94 and support hardware, such as pivoted lifting arms 76 having pivot points 74 (as shown in FIGS. 14A-14D), cooperate to move sheet return member 38 upward. A gap 78 in upper roller 36 allows unobstructed travel of sheet return member 38 past transport components.

In moving stimulable phosphor sheet 18 into an opening 50 of cassette 20, sheet return member 38 re-engages the restraint/latch mechanism that secures stimulable phosphor sheet 18 within cassette 20, as described in more detail subsequently.

It is noted that sheet return member 38 can force cassette 20 slightly but noticeably out of position in cassette loading section 12, so that an operator can visually ascertain that scanning and reinsertion are completed.

By way of reference, FIG. 14B shows, using arrow F, the direction of force applied to cassette 20 to obtain edge registration, as described with regard to FIG. 10.

FIG. 18 more particularly illustrates urging mechanism 46 that reverses the movement direction of stimulable phosphor sheet 18 at the end of travel (end point 42 of FIG. 9D). For the arrangement shown in the figure, motor 104 actuates a lifting mechanism 106 that pushes a lifting arm 108 upward. It is noted that a minimal/small amount of upward movement is needed, since reversal of roller 36 direction in transport section 30, as described earlier, moves stimulable phosphor sheet 18 in the direction for reloading into cassette 20. A number of different lifting mechanisms 106 can be employed for this function, as will be well known to those skilled in the motion control arts.

#### Sheet Registration

As illustrated in FIGS. 9A through 9F, proper registration of stimulable phosphor sheet 18 and guidance along its transport path promotes accuracy of image scanning and provides the precision for automated reinsertion into cassette 20. The perspective view of FIG. 10 shows the transport path of stimulable phosphor sheet 18 with coordinate axes for reference. Rollers 36 cooperate to stabilize the position of stimulable phosphor sheet 18 with respect to the xy plane and set the proper z axis distance to scanning optics. Registration of the cassette and plate is accomplished using a single registration edge, as will be described below with reference to edge 72.

#### Cassette

FIGS. 11, 12A, 12B, and 13 show particular features of cassette 20 relative to the scanning sequence described with reference to FIGS. 9A through 9F. Opening 50 exposes a lead edge 62 of stimulable phosphor sheet 18, as is best shown in FIG. 12B. Lead edge 62 provides a portion of stimulable phosphor sheet 18 that extends out from opening 50, beyond

a light-protected region, and allows manipulation and guidance of stimuable phosphor sheet **18** through transport section **30**, as described earlier. Lead edge **62** is a non-imaged area. That is, lead edge **62** is not considered as part of the “imageable” area of stimuable phosphor sheet **18**; imageable portions are protected from ambient light by enclosure within the light-protected body of cassette **20**.

To provide enclosure for stimuable phosphor sheet **18** that is substantially light-tight, cassette **20** has top and bottom covers **52**. Left and right side extrusions **54** support covers **52** and have edge guide features **60**, shown in transverse cross section in FIG. **12A**, that can extend along the length of stimuable phosphor sheet **18**. Stimuable phosphor sheet **18** itself includes a phosphor coating **58** on a plate **56**. It is noted that a tolerance is accommodated between the edge of stimuable phosphor sheet **18** and edge guide features **60** on side extrusion **54**.

FIG. **13** shows an edge of cassette **20** with side extrusion **54** removed, to allow visibility of a restraining latch mechanism **64** used for securing in place or releasing stimuable phosphor sheet **18** within cassette **20**. Mechanism **64** is one suitable type of restraint member and can be spring-held or otherwise forced inward to engage a notch/detent **66** along an edge of stimuable phosphor sheet **18**. Other suitable mechanisms will be known to those skilled in the art.

FIGS. **19** and **20** show a latch release **70** on cassette loading section **12**, with a portion of the obstructing hardware removed for illustrative purposes. In the arrangement shown, a spring **100** exerts a spring force that cooperates with a pivot point **102** so that latch release **70** presses inward, toward cassette **20**. Latch release **70**, acting as a release member, pivots restraining latch **64** on cassette **20** when the operator inserts cassette **20** into a cassette feed slot **68** (slot **68** is shown in FIG. **14A**, and is a component of cassette loading section **12**). In addition, the force exerted against cassette **20** urges it against an edge **72** (of cassette loading section **12**, as shown in FIGS. **6** and **14A**) which aligns cassette **20**. Thus, inserting cassette **20** into slot **68** (of cassette loading section **12**) provides the release of stimuable phosphor sheet **18** from cassette **20** for scanning and alignment of cassette **20** into edge registration (in the x direction of the yz plane) in the transport path.

It is noted that cassette **20** can be registered in the z direction (of the xy plane) by the addition of a mechanical force, for example, a spring or plunger. This may be desirable if the opening of cassette feed slot **68** is enlarged for manufacturability purposes or for ease of cassette insertion by an operator.

In one arrangement, a sensor (not shown) detects travel of latch release **70** to initiate operation of transport section **30** motors when cassette **20** is installed into cassette feed slot **68**. A limit switch or other sensor can be used to detect latch release **70** movement, using techniques and practices known to those skilled in the motion control arts.

In the embodiments shown herein, latch release **70** actuates automatically to release stimuable phosphor sheet **18**. Alternatives include coupling a solenoid or other actuator to latch release **70** to release stimuable phosphor sheet **18** under command from control electronics section **28** (FIG. **2**).

#### Gimbaled Scan Mounting

Radiation data reading apparatus **10** has a gimbaled scanning apparatus that enables scan housing **32** (FIG. **8**) to register to stimuable phosphor sheet **18** without overconstraint. With this mounting arrangement, scan housing **32** allows a number of degrees of freedom for registration, including allowing some movement along z and x axes and rotation

about the x axis ( $\theta_x$ ) and y axis ( $\theta_y$ ). Movement in y and rotation about the z axis ( $\theta_z$ ) are constrained in this arrangement.

FIG. **15** shows schematically scan housing **32** (represented as a rectangular box, without showing rollers **36** of transport section **30** attached) supported from the frame of chassis **14** to provide gimbaled action.

FIGS. **16** and **17** show, in front and perspective views respectively, hardware components used to effect this gimbaled arrangement. Along an axis A, parallel to the x axis as shown, scan housing **32** is supported at two suspension points, at the right **82r** and at the left **82l**. A third suspension point **80** is suspended by a flexible coupling **88**, such as a spring, from a fixed point **86** on the frame of chassis **14**. Flexible coupling **88** allows a measure of rotation about the x axis ( $\theta_x$ ) and back and forth movement generally in the z direction, as indicated by a dotted line C. Hinges **90r** and **90l** support suspension points **82r** and **82l** respectively, allowing a measure of rotation as indicated by a dotted line D. Best shown in FIG. **16**, pins **92r** and **92l** that extend from scan housing **32** are supported within hinges **90r** and **90l**, each providing essentially a single point of contact. A slight amount of movement in the direction of the x axis is permitted by this arrangement. Flexible coupling **88** is adjustable in one embodiment, enabling fine-tuning of the overall stiffness and angular response range of the gimbaled mount.

Hinges **90r** and **90l** suspend scan housing **32** from stationary hinge points **84r** and **84l**, respectively. This allows some rotational movement as indicated by a dotted line E, effectively providing movement in the direction of the optical axis z, with the cooperation of flexible coupling **88**. It can be observed that this arrangement constrains movement in the direction of the vertical axis y and constrains rotational movement about the optical axis z ( $\theta_z$ ), while allowing some measure of movement along z and x axes and rotation about the x axis ( $\theta_x$ ) and y axis ( $\theta_y$ ).

As is shown in FIGS. **16** and **17**, transport section **30**, with rollers **36**, is attached to scan housing **32**, with each roller **36** axially coupled to allow its rotational movement. Thus, when stimuable phosphor sheet **18** is held between at least two nips **40**, scan housing **32** registers to the surface of stimuable phosphor sheet **18** in a gimbaled manner.

Referring back to FIG. **15**, it can be appreciated that the gimbaled support of scan housing **32** can be effected in a number of ways, but still operate according to the basic principles described earlier. For example, flexible coupling **88** need not be a spring, but can be generalized to be a coupling that allows some measure of movement in rotation about the x axis ( $\theta_x$ ) and movement along the optical axis z. Flexible coupling **88** could suspend scan housing **32** from above as shown in FIG. **15** or could flexibly support scan housing **32** by protruding from below.

With respect to the horizontal axis x, support point **80** is between support points **82l** and **82r**. The couplings used for support points **82l** and **82r** extend from the supporting frame to the scan housing and provide axial alignment of scan housing **32** relative to the horizontal axis x. Couplings to support points **82l** and **82r** must allow some measure of rotation  $\theta_x$  about the horizontal axis x, at least about 2 degrees, but preferably 5 degrees or more rotation.

Support points **82l** and **82r** can be supported by suspension from the frame, as depicted in FIG. **15** and shown in the hinged arrangement of embodiments in FIGS. **16** and **17**. Alternate arrangements for supporting scan housing **32** at these points can include support from below, such as ball-and-socket support or hinged support, including using a rotatable platform, for example. Whatever gimbaled movement is

provided, it is important to support scan housing **32** to constrain movement in the y direction, for example by using gravity to support points **82l** and **82r**, and to constrain rotation about the optical z axis, or  $\theta_z$ . Rollers **36** of transport section **30** are mechanically coupled to scan housing **32**, with this 3-point coupling arrangement allowing the gimballed action that conforms the position of scan housing **32** relative to the surface of stimuable phosphor sheet **18**.

Radiation data reading apparatus **10** as described herein is advantaged for providing controlled guidance of stimuable phosphor sheet **18** along a substantially vertical transport path, minimizing the equipment footprint where floor space is at a premium. Automated extraction, scanning, erasure, and return of stimuable phosphor sheet **18** with cassette **20** allows enhanced efficiency of operation, since the operator need only insert cassette **20** into cassette loading section **12** and remove cassette **20** when the scanning and erasure operations have been completed. Compared with conventional scanning solutions, as described earlier in the background section, the apparatus of the present invention offers a low-cost solution, using gravity feed and offering repeatable operation.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the scope of the invention as described above, and as noted in the appended claims, by a person of ordinary skill in the art without departing from the scope of the invention. For example, various types of rollers could be employed. Various types of sensing devices could be used to detect the presence of the phosphor sheet in roller nips. Various types of scanning excitation sources and photoelectric detectors, familiar to those skilled in the diagnostic imaging arts, could be used. The apparatus of the present invention is particularly suitable where the stimuable phosphor sheet is at least semi-rigid, as defined earlier.

Thus, what is provided is an apparatus and method for scanning a stimuable phosphor medium having an exposed radiographic image thereon.

The invention has been described in detail with particular reference to a presently preferred embodiment, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The scope of the invention is indicated by the appended claims, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced therein.

#### Parts List

**10.** Radiation data reading apparatus  
**12.** Cassette loading/receiving section  
**14.** Chassis  
**16.** Scanning section  
**18.** Phosphor sheet  
**20.** Cassette  
**22.** Erase section  
**24.** Erasure radiation source  
**26.** Power supply  
**28.** Control electronics section  
**30.** Transport section  
**32.** Scan housing  
**34.** Optical scanning apparatus  
**36.** Transport roller  
**38.** Sheet return member  
**40.** Nip  
**42.** End point

**44.** Motor  
**46.** Urging mechanism  
**50.** Opening  
**52.** Cover  
**54.** Side extrusion  
**56.** Plate  
**58.** Phosphor coating  
**60.** Edge guide features  
**62.** Lead edge  
**64.** Latch  
**66.** Detent  
**68.** Slot  
**70.** Latch release  
**72.** Edge  
**74.** Pivot point  
**76.** Lifting arm  
**78.** Gap  
**80, 82r, 82.** Support point  
**84r, 84l.** Hinge points  
**86.** Fixed point  
**88.** Flexible coupling  
**90r, 90l.** Hinge  
**92r, 92l.** Pin  
**94.** Motor  
**96.** Finger  
**98.** Fan  
**100.** Spring  
**102.** Pivot  
**104.** Motor  
**106.** Lifting mechanism  
**108.** Lifting arm  
A, B. Axis  
C, D, E. Dotted line  
F. Arrow

The invention claimed is:

1. A cassette comprising:
  - a housing adapted to house a stimuable phosphor sheet, the housing including a light-protected region and an opening for extraction and/or insertion of the stimuable phosphor sheet;
  - a latch member for releasably engaging the stimuable phosphor sheet to secure at least a portion of the stimuable phosphor sheet within the light-protected region, wherein the latch member is disposed on a side of the cassette, and is configured to releasably engage a detent disposed in the sheet; and
  - edge guides disposed within the housing to guide movement of the stimuable phosphor sheet through the opening.
2. The cassette of claim 1 wherein a lead portion of the stimuable phosphor sheet extends outside of the light-protected region of the housing.
3. The cassette of claim 2 wherein the lead portion is at least 0.25 inches in length.
4. The cassette of claim 1 wherein the housing further including a non-light-protected region adjacent the opening, and a lead portion of the stimuable phosphor sheet is disposed in the non-light-protected region when the at least a portion of the stimuable phosphor sheet is secured within the light-protected region by the latch member.
5. The cassette of claim 1 wherein the latch member include a spring.
6. The cassette of claim 5 wherein the spring biases the latch member into engagement with the stimuable phosphor sheet.
7. The cassette of claim 1 wherein the edge guides are disposed within the housing along two opposing edges.

**11**

**8.** The cassette of claim **1** wherein the edge guides constrain movement of the sheet in a direction substantially normal to an extraction/insertion direction.

**9.** A cassette handling section of a radiation reading apparatus, comprising:

a loading section adapted to receive a cassette housing a sheet;

a pivotable latch disposed on a side of the cassette and configured to releasably engage a detent disposed in the sheet;

a latch release adapted to actuate the pivotable latch to release the sheet housed within the cassette; and

a guidance apparatus accepting the released sheet from the cassette and guiding the sheet out of the cassette.

**12**

**10.** The cassette handling section of claim **9** wherein the guidance apparatus guides the sheet in a substantially vertical direction and comprises at least three sets of opposed rollers.

**11.** The cassette handling section of claim **9** wherein the loading section is configured to urge the cassette against a reference edge to register the sheet.

**12.** cassette handling section of claim **9** wherein the latch release includes a spring cooperating with a pivot point.

**13.** The cassette handling section of claim **9** wherein the latch release is configured to urge the cassette toward a reference edge.

\* \* \* \* \*